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MOTOR VEHICLE CONTEST IN AMERICA.

EQUALLY in America as here, but with the added advantage that America is not, we believe, burdened with a preposterous locomotive Act, the motor vehicle question is one of those engaging public interest. As in France, and to a limited extent here, the newspaper press of America seem to have taken the matter up. In America, the contest is termed the *Times-Herald* vehicle contest—a name sufficiently indicative of its origin and support. The committee have now reported on the contest of November 30th last, and the *Electrical Journal* gives particulars of the report, from which we gather that, for comparison of gasoline and electricity, the gasoline was all supplied out of one barrel and estimated at 2 cents. per pound, in deducing expense. Its density was 0·688, and there was no attempt made to obtain a fluid of any particular specific gravity, as the committee very reasonably considered that vehicles ought to be able to use just what they could obtain on the road. Electrical energy was estimated on a cost basis of 10 cents. per kilowatt hour, and batteries rated at 75 per cent. efficiency, making the current, delivered to the motor, cost 10 cents. In testing the pulling power of the vehicles, the heaviest recorded was that of the Duryea vehicles, namely, 187 lbs. as against a horse's pull of 400 lbs., and in no case could the driving wheels be made to slip. The gasoline vehicles weighed from 1,200 to 1,800 lbs., the two electrically-propelled vehicles weighed 1,650 and 3,535 lbs. respectively, and the cost of a horse-power at the rim of the driving wheel was from 16·3 to 24·2 cents. for electricity, as against a minimum of 3·14 and a maximum of 43·6 cents. with gasoline. But the cost for the better gasoline motors did not exceed 11·40 cents. The Day cycle motors were not a success. In this type the exhaust takes place by the uncovering of the exhaust port at the outstroke of the piston by the piston itself. The exhaust in these motors was densely laden with unconsumed carbon which more than outweighed the advantage of the explosion every revolution. The Benz motor works on the Otto cycle, and is evidently a good motor. It receives its gasoline vaporised before entering the cylinder. The Duryea and others vaporised in the cylinder itself. The Duryea vehicle had trouble with its igniter, otherwise it appeared to be the best vehicle all round in mechanical efficiency of 65 per cent., a consumption of 3·24 and 3·64 lbs. at its two tests per horse-power at the rim of driver, and a pull of 187 lbs. at a maximum. The speed was only 434 feet per minute and the horse-power 1·16 at the rim, so that there is a good prospect for better results at higher speeds, the improvement in other vehicles being about proportional to the increase of speed, as we should expect with gas motors.

An interesting feature of the Benz motors is that though only fitted with two speeds nominally, the explosive force

can be varied by regulating the relative supplies of gas and air.

There appears to have been some trouble with vibration due to the cylinder action of the motors. Some had cylinders placed transversely to the axle, others were parallel therewith, and it is concluded that the vibration difficulty must be settled by means of two cylinders placed on opposite sides of the axle and balancing each other by their mutual reactions.

In the Morris-Salom electrical car the batteries were rated at 50 ampere hours, with a discharge rate of 5 amperes. This vehicle is propelled by a couple of 1½-horse power motors. The Sturges vehicle, on the other hand, carries a single 3-horse motor. The two motors are but little more efficient than the single motor, though better mounted. The double motor, with its possibilities of series-parallel control, hardly seems, therefore, sufficient to warrant the complication of two motors, though they have the advantage of enabling the wheels to run independently of each other round curves. With single motors other devices need to be arranged to allow for this. In almost every case this is done in gasoline vehicles by means of some form of differential gear with sprocket chain driving.

In testing the pull per 1,000 lbs. of load to overcome tyre resistance the following is an abstract of results.

5·23 lbs. on a steel tyre.
4·34 „ „ a solid rubber tyre.
8·50 „ „ pneumatic.
14·6 „ „ „ deflated.

These resistances are due simply to the tyres. The axle resistances reduced to a common lever arm are per 1,000 lbs.

18·7 lbs. with steel tyres.
7·2 „ „ solid rubber.
5·7 „ „ pneumatic.

Thus the net advantage is with the solid rubber. Tyres affect results in that unless the wheels revolve exactly in the plane of forward motion there is end thrust produced. The steel tyre has no self-adjusting quality such as is possessed by the India-rubber, and hence its large effect on axle friction. The actual bearing friction per foot of lever arm is small and in every case may be taken as 5·7 lbs. The axle friction as a whole is given above, and that of the pneumatic tyred wheel is practically all bearing friction, the excess of the other tyres over 5·7 lbs. being the amount due to the tyre action. Reduced to the radius of the bearing, friction is 120 lbs. per 1,000, or equal to a coefficient of 0·12. It is clearly of greater importance to overcome the end friction of a journal than the comparatively small simple bearing friction. The experiments did not go so far as the determination of road resistance; these were stopped by a fall of snow, or it was intended to prove the resistance of various road surfaces by measuring the energy of the electrical vehicles. A few leading dimensions of the Duryea vehicle will be of interest. They do not differ much from those of other vehicles. Weight on drivers, 728¾ lbs.; steerers, 478¾ lbs.; total, 1,207½ lbs.; wheel base, 57½ inches; gauge: drivers, 55 inches, steerers, 53¾ inches; radius of drivers, 22⅞ inches, steerers 18¾ inches; tyres, pneumatic; two cylinders, each 4 inches diameter, 4½ inch stroke, Otto cycle.

The general impression we gather from the report is not favourable to the electric vehicle except on smooth asphalte in City work, where we do not look on the gasoline vehicle as so safe or pleasant.

Fast Speed Telegraphy.

To those who have had little or no experience in the commercial practice of telegraphy, there is something very fascinating in the idea of fast speed working, but it may be questioned whether the subject has really been considered in all its aspects by those who are so enthusiastic in the matter. A great deal of talk is indulged in by those who have succeeded in beating the record speed obtained with the Wheatstone automatic, namely, 600 words per minute, and also it is, we believe, pointed out that the Wheatstone is, in practice, never worked at 600, but only at 300 to 400, the suggested inference being that the apparatus is, for mechanical reasons, incapable of maintaining the highest speed, as the adjustment is then much too delicate. What are the facts, however? The Wheatstone is not run at a low speed because it cannot mechanically maintain a higher one, but simply for the reason that it is practically impossible for the clerical staff to deal with the paper slip as it "pours" out. Those who do not practically have to handle the slip know nothing about "R Qs," in other words, of corrections and explanations, which become very numerous and lengthy, and increase in a much greater proportion than the speed increases. This does not apply to anything like the same extent with long press messages as it does with the ordinary short private telegram, but as a matter of fact the suggestions for fast speed telegraphy (as for example as suggested by Mr. P. Delany) mostly relate to ordinary traffic, and in such cases, paradoxical as it may seem, the message work is actually turned out quicker with the transmitter running at a rate of 200 than at a rate of 300 words per minute, and this is the case when the smartest of the staff are dealing with the work. Unless, therefore, some means or method can be devised for enabling the work to be dealt with in a manner not yet found to be practicable, the idea of running the slip and sending and receiving signals at the rate of 1,000 words per minute may be electrically and mechanically possible, but commercially it is rather a wild one.

Electricity Direct from Carbon.

Dr. Coehn has succeeded, according to the *Elektrotechnische Zeitschrift*, after a long investigation, in producing a voltaic cell with a carbon anode, that is to say, a battery in which the carbon pole is consumed. The starting point in Dr. Coehn's investigation was a fact well-known to electro-chemists, viz., that when carbon is used as an anode in electrolytic processes, a solution which gives a brown colour to the electrolyte is often produced. By an elaborate series of experiments, Dr. Coehn has determined the conditions under which the carbon anode was oxidised so as to produce carbonic acid and carbonic oxide only. It was found that a certain temperature and a certain current density was necessary to produce this result. The electrolyte is dilute sulphuric acid, and this must also be of the proper density. He next succeeded in precipitating upon the cathode the carbon dissolved from the anode. To obtain a constant battery, it was now only necessary to supply oxygen at the cathode to consume the carbon, and for this purpose an anode of peroxide of lead was used. The element gives an electromotive force of 1·3 volt. This is a much higher voltage than has hitherto been obtained in batteries, such as Borchers's, in which the energy is derived from the combustion of carbon. The greatest practical objection to this element appears to be the use of so expensive a material as peroxide of lead as an anode. If peroxide of lead occurred in nature in sufficient abundance the case would be different, since the reduction of the ore to the metallic condition would profitably go hand in hand with the production of electric energy. Unfortunately, peroxide of lead is not an abundant lead ore, but there are many other metals which occur abundantly and cheaply as oxides, and it is possible that these may be capable of being utilised in the new battery. We give a full account of Dr. Coehn's investigations in another column.

CENTRAL STATION WORKING.

In the above series now appearing in the *Electrical World* of New York, attention is drawn by Mr. G. T. Hanchett to a number of "kinks" or "wrinkles," which he believes should be known by all central station managers. Most of these are already known to those whose duties lie in superintending electricity supply works; at least by those who have received practical training of mechanical engineering before taking up the onerous duties before referred to. The first "wrinkle" which we receive from him rightly exposes the obnoxious practice which is often resorted to by dishonest coal dealers, and even sometimes by those who desire to deal fairly, namely, that of wetting the coal to increase its weight, and when we remember that bituminous coal is susceptible of an increase of from 20 to 30 per cent., and that without betraying the fraud by its appearance, it will be seen how serious the effect of this fraud would be on central station economies. If water must be added to coal, as some dealers argue, to shovel it with comfort, by all means do so, but not until the coal has first been weighed.

Mr. Hanchett's experience in the pounding of his main bearings and crank pins would lead us to suppose that something is radically wrong with the design of his engine, because, from the elaborate means which he adopts of tightening up the brasses of the main bearings, bottom ends, &c., it is presumably a not uncommon thing for him to find the engine knocking itself to pieces after a very short run. Admitting that it is most aggravating to have a knock in one's engine, it cannot be supposed that brasses will wear so rapidly, that a little adjustment now and again will not eliminate the same without having recourse to the elaborate means of determining the amount of adjustment necessary adopted by Mr. Hanchett. In very large engines, his method of setting them on the dead centre, disconnecting the eccentric rod, and working the valve by hand, thereby admitting steam alternately on either side of the piston with the object of pushing the reciprocating parts backward and forward the amount of the play, is fairly well known and practised, but we venture to think that a more practical and surer method is to have the edges of the brasses cut away, so that half-a-dozen or so very thin liners can be placed between them, and when any knock develops, remove one of these liners, and it will cease; at the same time the engineer knows exactly the amount of wear taken up, and as large bearings must be adjusted very carefully, and by small increments, this plan is much to be preferred to the more rough and ready means adopted by Mr. Hanchett, as above described.

Instead of the well-known oil rings which are so universally fitted to self-oiling bearings, Mr. Hanchett employs a chain, which, by passing through two holes bored tangentially to the shaft, enables him to obtain 180° of contact, instead of one point of contact obtained by the oil rings. This chain brings up a great quantity of oil, is not so liable to become stopped or slip, and provided sufficient means are taken to prevent it becoming tied in a knot or kinking, we think it an improvement on the oil rings.

A very neat, and no doubt effective means of immediately localising a fuse which has gone in a station where there is a multiplicity of circuits is described, and is worth repeating. "A lamp is connected at the fuse terminals, and is therefore short-circuited thereby. When too heavy a load or a short-circuit comes on the line protected by that fuse, the latter blows and the lamp at once lights up."

The remainder of the article deals with the annoying refusal of a dynamo to "build up its voltage," or, as we express it, "excite itself," and as a cure for the refractory machine advocates the well-known steps of exciting the field by means of another dynamo.

The fifth contribution to the *Electrical World* is from the pen of Mr. A. N. Rathbun, and is entirely devoted to arc lighting by high voltage continuous current dynamos. The enormous demand for arc lighting in America necessitates that this class of lighting should be accomplished with as little a loss in distribution as possible, and for this reason the favourite arc lighting machine is one which will supply current to 60 lamps connected in series. Even the necessary pressure of 3,000 volts required to supply these 60 lamps is not considered sufficiently economical, and two dynamos are often connected in series, so that 120 lamps are burning on one circuit. Three 3,000 volt machines in series involve a potential that for successful working calls for the best rubber and oil insulators, and it has been often found that when 6,000 volts have been exceeded, the liability to breaking down of the insulation is marked, and 6,000 volts appears to be the limit of pressure that can safely be allowed on an arc lamp circuit.

Mr. Rathbun deals very fully with the manipulation of these high-voltage machines, and points out that in the open coil machines, which have few segments in the commutator, the profuse sparks which occur in normal operation is not a serious matter on account of the small quantity of current transmitted. When the machine is started, and has attained its speed, the brushes are drawn considerably back of the neutral point, and the switch short-circuiting either the field or the armature, is opened. When the machine builds up, there is sufficient evidence at the commutator by a spark over an inch long. The brushes are now slowly brought forward to the neutral point, and the current rises, the spark shortening as this is performed. When the spark reaches a length of $\frac{3}{32}$nds of an inch, the brushes are fixed. If we advance the brushes still further, the spark seems to disappear under the brush, and the neutral point is attained. If, however, the load or the speed diminishes, or the brushes be moved still further forward, a furious flashing occurs between the brushes, which completely throws the load off the machine, therefore Mr. Rathbun advocates the allowance of a spark of $\frac{3}{32}$nds of an inch in continuous running to allow of a margin.

We are reminded of the liability of high tension arc series machines developing faults to case, and are exhorted to pay special attention to their insulation. If, however, the machine should develop a fault to case, the rough and ready means of locating the same is as follows:—One end of a flexible cord should be pressed against the framework, and first one brush and then the other connected with the free end, looking carefully for arcs. Static sparks may occur, but they can be readily distinguished from the little arc produced by a feeble earth. If arcs are found, the quickest way is to make firm contact between the brush and frame, until the fault becomes more pronounced, when it will indicate the whereabouts by a dart of flame on the magnets or armature, and can thus be detected.

Static discharges are sometimes responsible for the breaking down of the insulation of high voltage machines, and breakdowns of this kind are very aggravating. To avoid the punctures in the insulation of the machine through this cause, Mr. Rathbun has found it convenient to provide a legitimate path for the discharge by connecting the frame and copper circuit with a vacuum tube. This allows the static discharge to pass, but is somewhat of a barrier against the normal voltage of the machine.

Leakages to earth on an arc circuit are most readily detected. By the construction of the circuit it is divided into several sections of 50 volts each, and the earths generally occur in one of these sections of the line connecting the lamps. The method advocated, which is based upon the principle of the Wheatstone bridge, is very convenient for the localisation of these earths, and consists of a circuit of 50-volt 8 C.P. incandescent lamps, of a number equivalent to the arc lamps, shunted across the terminals of the dynamo. Let it be supposed, for example, that between the ninth and tenth lamp an earth has developed. The fall of potential between the positive terminal and earth is 450 volts, and the fall of potential from the positive terminal to the wire between the ninth and tenth incandescent lamp is also 450 volts. Hence, if these two points are connected no current will flow, and by simply inserting a voltmeter or some indicating device between the earth and the terminals of the incandescent lamps in succession, one will be found where the current is a minimum, and between the corresponding arc lamps on the line the earth will be located.

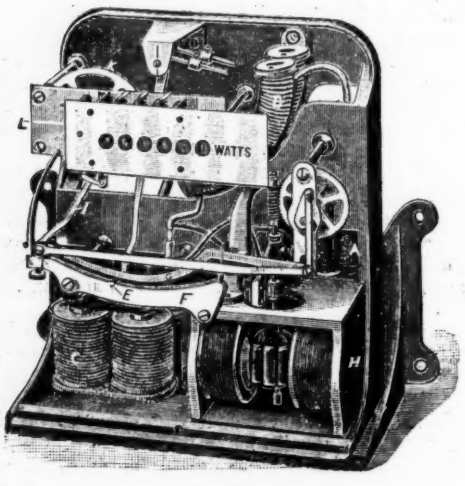
The time cannot be far distant when central station engineers in this country will be called upon to deal with series arc lighting of considerable magnitude, and we have thought it well to place before them some of the problems that have confronted a prominent American engineer, and the remedies suggested by him for the various difficulties which he has experienced.

THE BALDWIN ELECTRIC METER.

NOTHING is so comforting, says the New York *Electrical Engineer*, to a station manager, as the knowledge that his customers' meters are accurate, in the first place because it insures the proper income for the station output, and, secondly, because it removes the annoying complaints of overcharge by customers.

The Baldwin Electric Meter Company, of Washington, D.C., have just placed on the market a recording electric meter, of decided novelty, which is claimed to possess, in a high degree, the valuable qualities of reliability and accuracy. The meter is constructed so as to cut itself in circuit on one lamp, and to register that one lamp with as much certainty as its full capacity of lamps. It can also run slow or fast, above the normal speed or below the normal speed, and yet the current consumption can always be read with positive accuracy within 1 per cent.

The figure shows the construction of the meter. The current enters at the binding post, A, and traverses the solenoid, B, and cut-out, C, and then takes its exit at the binding post, D. The solenoid operates in the usual way to swing a fulcrum pointer, E, whose zero point is at the left-hand end of the backing plates, F. Above this fulcrum pointer is a cam-shaped lever, G, whose right-hand end is reciprocated periodically by the motor and crank movement, and whose left-hand end is connected by the connecting rod, I, to the ratchet wheel, K.



When one or more lamps are turned on the circuit, the armature of the cut-out, C, shown at the bottom, is brought down on its contact, thus putting in circuit, and starting at full power, the motor, H, the fulcrum, E, also at the same time, moving forward, taking position further and further to the right, as more and more current is turned on the circuit. The binding post, near cut-out, C, connects with one side of the circuit, and the spring contact through the motor with the other side.

As the cam lever, G, is reciprocated by the crank movement, it strikes the fulcrum pointer, which is bent down until supported by the backing plates, F, and the left end of the cam lever is lifted up by the connecting rod, I, which movement is communicated to the ratchet wheel, and registered on the counter, L.

It will be seen that the more current on the circuit, the further to the right the fulcrum pointer takes its position, and the greater will be the movement of the cam lever, and the greater the rotation of the ratchet wheel. The cam lever is so designed, as to give rotation to the ratchet wheel proportional to the current passing through the meter, and great accuracy is obtained throughout the whole range and capacity of the instrument. When the cam lever is in its uppermost position, the fulcrum pointer touches no part of the instrument, and it is perfectly free to take up a new position, which indicates a change in the current strength.

The motor, H, has power greatly in excess of its required work, being an efficient and well constructed iron motor. Although taking but 7-100-ampere, it always runs at its full power, has good brush contact on the commutator, and maintains its speed very close to the normal, being connected independently directly across the mains. For any motor speed, accurate readings of current consumption may always be had by taking the motor speed in the following way:—The normal crank speed is three revolutions per minute, or five revolutions in 100 seconds, and if five revolutions of the crank are timed, and it is seen that such five revolutions take place in 105 seconds, the motor is running just 5 per cent. slow, and 5 per cent. should be added to the counter reading for obtaining an accurate result. If the crank should show five revolutions in 97 seconds, the motor is running 3 per cent. fast, and just 3 per cent. should be subtracted from the reading of the counter, in order to obtain the true final consumption of current. Great accuracy is thus obtained for any motor speed.

The meter has a slow speed motor, making 300 revolutions per minute, and requires little attention; it is very economical, since no current is consumed in the meter itself when no lamps are on the circuit. The meter shown in the cut is for the two-wire direct current system, and the three-wire meters are constructed in the same way with two solenoids.

THE RÖNTGEN X RAYS.

THE most remarkable results in the new photography are, without doubt, those communicated this week from America. We have already published Edison's telegram to Lord Kelvin, in which he announces his discovery that tungstate of calcium is by far the best substance yet discovered for the manufacture of phosphorescent screens for the *X* rays. Doubtless a host of experimenters will be testing this result, and it is to be hoped will be able to confirm it, since the new substance will be very much cheaper than the barium platino cyanide hitherto used.

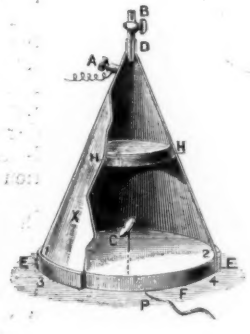
Prof. Woodward, of Harvard University, has constructed a new *X* ray lamp, which promises to reduce the length of exposures below anything yet attained. Lenard, as is well known, projected his rays through an aluminium window, and it has been several times suggested that glass should be replaced by aluminium in the *X* ray lamp. This idea has been carried out by Prof. Woodward, and apparently with the greatest success, since he has been able to obtain with it clearly defined photographs of the hand, in five seconds. He is said to have obtained this result with E.M.Fs. of 25,000 to 30,000 volts, which would correspond to a spark length of not more than 1 cm. We take the description of this remarkable lamp from the *Electrical World*, N.Y.

From the diagram it will be seen that this new form of ray lamp is that of a cone, and its characteristic difference from the ordinary Crookes tube is that the sides or walls of the lamp, H, H, are made of sheet aluminium $\frac{1}{10}$th inch in thickness; the base of the lamp, 1, 2, 3, 4, is of solid glass, practically a plug fitted into the base of the aluminium cone with plaster of Paris, and made air-tight. A metallic ring passes around the base of the cone at E, E, and holds the sides of the cone firmly to the glass bottom. Through a point, F, a little to the side of the centre of the glass base, passes the cathode pole into the lamp, and at the end of this is fastened a platinum disc at such an angle as to be parallel with the side of the lamp at the point X. At the top of the lamp, and directly connected to the metallic side, is the anode pole, A, and at the top of the cone is a glass tube with a stop-cock, so that the air may be exhausted. This glass tube is also fastened in with plaster of Paris, and bound by a metallic ring. A circular wooden disc is fastened on the inside of the metallic cone at H, H, to prevent any collapse of the sides on exhaustion. By this construction it has been found that the difficulty from the absorptive power of the rays by the glass of the Crookes tube has been eliminated in a most marked degree.

Tesla publishes in the *Electrical Review*, N.Y., an account of some remarkable experiments which he has been making

in X ray photography by means of a lamp excited by his high frequency currents. The most interesting feature about Tesla's experiments is the great distances through which he has succeeded in projecting the X radiation. A photograph is reproduced, which is stated to be the right shoulder of a man, showing ribs and shoulder and upper arm bones, taken through clothing, board, &c., at a distance of 4 feet. The upper arm bone is distinctly visible, though badly defined, but it requires an effort of the imagination to see the ribs. Another photograph—a wire pattern taken through a wooden cover at a distance of 11 feet with one-half hour's exposure—is quite distinct. These experiments, though confessedly made with crude apparatus, show that by the use of the Tesla currents there will be no difficulty in photographing the interiors of the thickest parts of the animal body.

The lamp used by Tesla is of the unipolar type, and he mentions a curious fact observed by him in connection with the production of high vacua in these lamps. After the bulb has been exhausted to a tolerably high degree by the ordinary vacuum pump, the pole is connected to the terminal of a high frequency coil. The effect of the discharge when continued for some time is to greatly increase the vacuum. Tesla reasons, with some plausibility from this experiment, that the electrified particles of air, of which the cathode discharge is supposed by some physicists to consist, are actually projected through the glass sides of the bulb. There is, however, another possible and more probable explanation of this phenomenon, namely, that air particles are carried through the glass-like ions passing through an electrolyte. The experiments of J. J. Thomson have shown that the X rays cause a kind of electrolytic dissociation even in the best insulators, and we can well imagine that there may be an electrolytic transference of the air particles through the glass. Several experimenters besides Tesla have



observed that the vacuum of the Crookes tube seems to improve for some time after it has been first used. Tesla is of opinion that the photographic action of the X rays is due to the bombardment of the sensitive film by material streams. This is, we think, carrying the radiant matter theory too far. The lengths of the exposures required with the Tesla apparatus are by no means very short, compared with what has been already accomplished. The bones of the human limbs required from a quarter of an hour to an hour. An outline of the skull was easily obtained in 20 to 40 minutes. "In one instance, an exposure of 40 minutes gave clearly not only the outline, but the cavity of the eye, the chin and cheek and nasal bones, the lower jaw and connections to the upper one, the vetebral column and connections to the skull, the flesh, and even the hair."

It may be interesting to medical men to know that Tesla has noted some strange effects when the head is exposed to a powerful radiation. He finds that there is a tendency to sleep, and time seems to pass quickly. There was a general soothing effect and a sensation of warmth in the upper part of the head. Who knows but that the X rays may yet banish insomnia and *ennui* from the world.

Prof. Stine, of Chicago, has been making some experiments in what he is pleased to call by the objectionable name of "sciagraphy." These are mostly now well known and often repeated experiments. It may be of interest to mention that he tested the rapid interrupter used successfully by Siemens and Halske, consisting of a dynamo commutator rotated at a high speed. Stine tried different rates from 500 to 4,000 interruptions a minute, but found the results to be very inferior to those obtained with a slower interrupter. The difference of experience in these two cases is probably due to the difference in the induction and battery power of the coils.

The interesting question as to the exact spot in the tube from which the X rays proceed appears to be as yet by no means settled. Röntgen considered that they proceeded from the place where the cathode rays impinged upon the glass, and this has been pretty generally accepted. In tubes like the "focus tube" the rays apparently proceed from the anode; but the anode happens in this case to be the point of impact of the cathode stream. These two facts have been summed up by the statement that the rays proceed from the "anti-cathode." But some recent experiments of Professor Henry A. Rowland, described in the *American Journal of Science*, appear to upset even this more general statement. He says:—

"We have, in the short time we have been at work, principally devoted ourselves to finding the source of the rays. For this purpose one of our tubes, made for showing that electricity will not pass through a vacuum, was found to give remarkable results. This tube had the aluminium poles within one millimetre of each other, and had such a perfect vacuum that sparks generally preferred 10 centimetres in air to passage through the tube. By using potential enough, however, the discharge from an ordinary Ruhmkorff coil could be forced through. The resistance being so high, the discharge was not oscillatory as in ordinary tubes, but only went in one direction. In this tube we demonstrated conclusively that the main source of the rays was a minute point on the anode nearest to the cathode. At times a minute point of light appeared at this point, but not always.

"Added to this source the whole of the anode gave out a few rays. From the cathode no rays whatever came, neither were there any from the glass of the tube, where the cathode rays struck it, as Röntgen thought. This tube as a source of rays far exceeded all our other collection of Crookes tubes and gave the plate a full exposure at five or ten centimetres in about five or ten minutes with a slow-acting coil giving only about four sparks per second.

"The next most satisfactory tube had aluminium poles with ends about three centimetres apart. It was not straight but had three bulbs, the poles being in the end bulbs and the passage between them being rather wide. In this case the discharge was slightly oscillatory, but more electricity went one way than the other. Here the source of rays was two points in the tube, a little on the cathode side of the narrow parts."

It would appear from Rowland's experiments that the anode, where it is struck by the cathode stream, is sometimes, but not always, the source of the X rays. Fuller details of these experiments are necessary before they can be reconciled with the apparently different results of other experimenters.

"Radiography," "sciagraphy," and "scotography," appear still to be struggling for precedence, as the name for the new science, especially in America, where they are not so diffident about adopting a new name as on this side of the pond. The difficulty appears to lie in finding a name for the agent by which the new pictures are produced. We may have long to wait before the nature of the X radiation is thoroughly determined. Meanwhile, the best course would appear to be to give up the attempt to form a name on the analogy of photography, in which the agent which produces the "graph" is indicated, because it is well known. In such a word as telegraphy, the leading characteristic of the "graph" is indicated in the prefix; and this, we think, is the analogy that ought to be followed in giving a name to the new science. What appears to be most distinctive about the new photography is, that it gives a "graph," or picture, of the inside of things, or, as the Greeks would have called it, το εσω, the within. "Esography" would, therefore, be a name formed on the analogy of telegraphy, and would have the advantage of being much more distinctive than either "sciagraphy" or "scotography." "Sciagraphy" has already been appropriated to express something else as long ago as Plato; "scotography" would include the production of pictures by the ultra-violet and the ultra-red rays of the spectrum, and therefore would not be so distinctive as "esography," since there is at present only one way known of depicting the "in'ards" of things.

HOW TO PHOTOGRAPH AND SEE THROUGH OPAQUE BODIES.

By E. ANDREOLI.

If Professor Crookes were not in Johannesburg, where he is giving evidence in the great case of the cyanide patents, we should have heard from him about his own experiments on his tubes, the X rays of which are the great "draw" in the chemical, medical and electrical laboratories, as well as in the scientific societies, and in the conversazione or fashionable assemblies, where, already, professionals deliver lectures and make wonderful performances, which, in former centuries, would have brought them in close contact with the representatives of justice and procured them introductions to the prison, the rack, and the stake.

Phantasmagoric demonstrations of radiography are already made in London music halls. In a few months, showmen got up as sorcerers, will display the great wonders of science in their booths and show the spectators their own bones and their inside *ante mortem*.

We already know what N. Tesla thinks of the new photography, and his theory, as well as his experiments, are very remarkable.

We are all anxious to know what Prof. Crookes will say about the production of radiographic shadows, the new use to which his tubes have been adapted since the last two months. No doubt the author of "Electricity in *transitu* from Plenum to Vacuum," will have some highly interesting statements to make on the manifestation, or, rather, revelation to human eyes of what was considered, up to now, as the invisible.

Photographers, electricians, chemists, have tried their hand at this new photography which is the great wonder of the day, and the articles published on this occult science have elicited everywhere the greatest excitement and curiosity. There are very few men who do not know of the prestigious but sometimes *macabre* views obtained by radiography, but there are still fewer who understand this new photography, which is still considered as the monopoly of the initiated, who have at their disposal powerful electric generators of high frequency and tension. This fascinating process has not yet, however, been put within the reach of every single person, having only at his disposal a tube and a few electrical appliances. Messrs. Ducretet & Lejeune, of Paris, who, a few years ago, popularised the Tesla experiments in constructing simple and inexpensive apparatus which allowed every student to realise the high tension phenomena of light or luminosity, have now put electricians, medical men, &c., on the way of using the radiant tubes for producing the all-penetrating X rays without the costly installation of an alternator, of a transformer of 10 to 50,000 volts combined or not with a Leyden jar battery, and generally accompanied by the more or less important breaking up of numerous vacuum tubes.

The arrangement recommended by Messrs. Ducretet and Lejeune, and which is shown in fig. 1, consists of a Ruhmkorff coil, B, giving a spark of 30 mm., 45 to 50 mm., 70 to 75 mm. and 120 mm. C is an aluminium sheet placed in the slide on which the object to be reproduced is exposed under the radiant tube, *t*, which, supported by P, is connected by its top terminal to the negative pole, and in its lower part to the positive pole of the coil. In the slide, the gelatino-bromide plate must be placed film upwards. The part of the tube near the anode must show a green fluorescence, which may be projected at will on the subject to be photographed; this fluorescent space can be displaced by means of the magnet.

It is important to note the directions given by Messrs. Ducretet and Lejeune. They say, 1st, that rapid vibrations of the break and make do not give as satisfactory results as when the Neef or the mercury Foucault interrupter is used. 2nd. That it is advantageous to switch on the coil for, say, four minutes and then to switch it off for one minute and so on. They also add that short Crookes tubes are not so good as long ones and are much less durable, because they soon show the Hittorff vacuum where the fluorescence is absent and therefore no X rays are produced. Those of our readers who may entertain some doubt about the efficiency of an ordinary induction coil for producing sharp shadowgraphic effects have only to examine fig. 2, which represents the hand photographed in fig. 1.

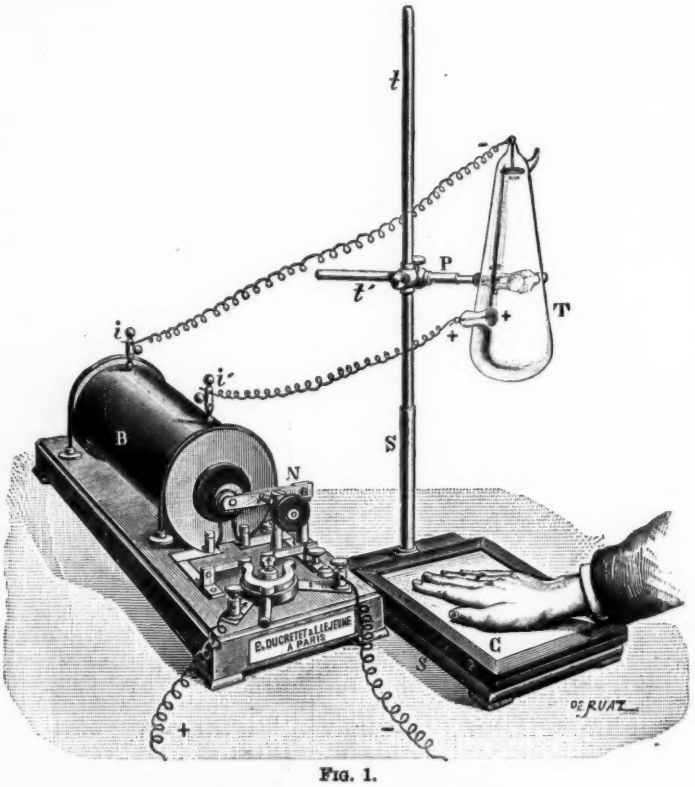


Fig. 1.

Fig. 3 represents the Hittorff apparatus; this scientist had observed that when a certain degree of vacuum is reached the induction spark will not pass any longer through the space, however short it could be, which separates the two electrodes of a Geissler tube. At this extreme limit of vacuum, the spark given off from the points, P P', lighted a long Geissler tube, T', but not the Hittorff perfect vacuum tube, T.

According to the nature of the objects to be photographed and to the size of the Ruhmkorff coil, the exposure takes from 10 to 30 minutes; the distance between the photographic plate in the slide and the tube may vary between 4 and 8 inches. Experiments made by Messrs. Buguet and Gascard taught us that by interposing a screen covered with a fluorescent substance, such as platino-cyanide of barium, or pentadecylparatolycetone, it is very easy to find out the difference between diamonds and paste, without taking them out of their setting (*Comptes Rendus de l'Académie des Sciences*, page 457, No. 8, February 24th, 1896).

The applications of these fluorescent screens are very striking. No doubt, taking photographs of the invisible, is a highly interesting phenomena; but the field of radiography, or rather of shadowgraphy, is rather limited, and is almost nothing in comparison with this apparently supernatural cryptoscope which allow our eyes, assisted by fluorescence, to look beyond our own flesh and to see in the darkness through opaque bodies. Messrs. Ducretet and Lejeune give the following instructions for substituting the cryptoscope for the radiograph, by means of a screen made of a sheet of glass, or cardboard, evenly coated with a layer of platino cyanide of barium, &c. The experimenter need not have any

photographic plate if he uses this screen, and instead of having recourse to a more or less prolonged exposure, followed by developing and fixing the image, &c., he can instantaneously see by looking on the screen the shadow and the interior of opaque bodies; to arrive at such astonishing, startling results, the Crookes tube must be thoroughly surrounded by a black envelope in order to suppress the action

Fig. 2.

of the green light produced in the tube, and the interrupter screw of the induction coil must also be carefully covered so as to hide the spark.

A shadowgraph can be taken in daylight, but if you want to see through your hand, your purse, if you desire to read a letter in a closed envelope, to ascertain what is in a box, &c., you must be quite in the dark, when the fluorescence will unveil for you the unseen.

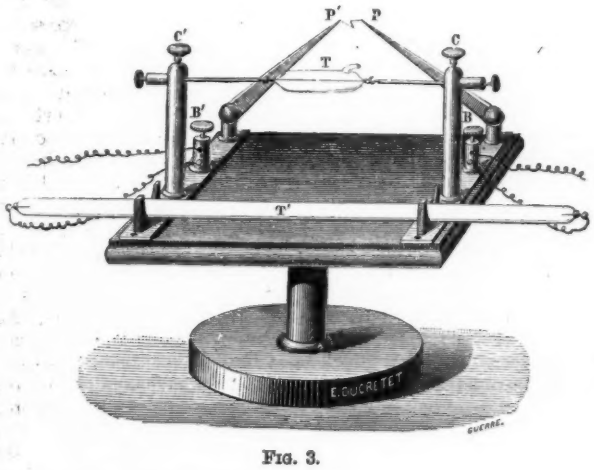


Fig. 3.

A large size Crookes tube, specially made for Röntgen experiments, may be sufficient for an object measuring 12 × 16 inches, but for larger surfaces, and especially for laboratory and surgical experiments, it is necessary to have a battery of tubes. This is, from a practical point of view, the great superiority and utility of cryptoscopy by aid of fluorescence, which when better known, will be applied on a very large scale to the study of the human body, and no doubt to many other industrial and scientific purposes.

ELECTRIC ELEVATORS.

The American Institute of Electrical Engineers devoted a recent evening sitting to a discussion on Mr. Sprague's paper, which has been appearing in these columns during the past few weeks. The following *resumé* of the proceedings is given by our contemporary, *Electricity*, of New York :—

Mr. Hutchinson, who opened the discussion, said that during the past few weeks he had made a series of tests of the Sprague elevators in the Postal Telegraph Building, the results of which formed his text. At the previous meeting figures had been called for, and these tests had been undertaken to supply them. It had been intended to continue these tests over a greater length of time, but Mr. Hutchinson had been unable to accomplish it. He believed, however, that they fairly represented the working results of the Sprague elevator.

These results are shown in the appended table :—

Miles of Travel.

Car.	10 to 11.	11 to 12.	12 to 1.	1 to 2.	2 to 3.	3 to 6.	Total.
1	1·76	1·14	·90	·97	1·10	3·32	9·19
2	1·72	1·10	1·10	1·01	1·10	3·94	9·77
3	1·72	1·27	1·10	1·12	1·23	3·85	10·29
4	1·78	1·05	...	·22	1·12	3·34	7·51
5	2·33	1·87	1·78	1·84	2·00	5·05	14·87
6	2·33	1·87	1·78	1·84	2·00	5·68	15·50
Car miles	11·64	8·30	6·66	7·00	8·55	25·18	67·11
Kw. hours	49·2	34·3	32·9	32·9	37·0	104·1	290·3
Kw. hours / Car miles	4·23	4·14	4·95	4·70	4·33	4·07	4·33

A communication from Mr. John W. Lieb, assistant general manager of the Edison Illuminating Company, was next read. This gave much interesting data in regard to the supply of current to electrical elevators. The Edison Company, he said, required, when they made connections with an electric elevator, that the latter should not by its operation cause a variation of more than 3 per cent. above or below on the 120-volt circuit, or of 6 per cent. on the 220-volt circuit. These requirements were easily met where the supply was taken from the street mains. It could not be met, however, in isolated plants, and he did not believe it was so economical to operate from isolated plants as it was to obtain current from the street mains. In the latter case the disturbing influences decreased rapidly with the number of elevators supplied. Where a single or a few elevators were to be supplied, it constituted one of the most unprofitable loads that a station could have, but where the number was multiplied it became more steady, and therefore more profitable. The cost to operate an elevator from the street mains often did not exceed $18 to $25 per H.P. year, and at that figure there was a profit to the Edison Company, although it could not be done for that figure in an isolated plant. Mr. Lieb's paper was highly favourable to the electric elevator when supplied from the street mains.

Mr. George Hill presented a carefully prepared and voluminous manuscript in defence of the hydraulic elevator, and attacking in specific and general terms the Sprague. By innuendo he characterised the latter as a "show" machine and the tests as "cooked to order." He proclaimed himself in favour of the drum electric elevator for such service as it was adapted to, viz., to slow speed service—300 feet per minute or less—but opposed to the Sprague type, which he denominated a "screw machine." It had been claimed, he said, that the latter was more economical than the hydraulic; but he was prepared to show, from figures obtained at the Postal Telegraph Building, that it was a very *un*economical apparatus. Stepping up to the black board, he drew a diagram representing the travel of the elevator through a number of stories. He said that the electric motor was called upon to work on its weakest point—that in starting it took abnormal current, and it was only when it got up to speed that it used energy economically. When in a tall building the elevator ran from bottom to top without stopping, this excess of current was required but once, lasted but a short time, and formed but a relatively small increment upon the full speed current. Under such conditions the electric elevator showed to advantage; but when it stopped at each floor, this increment was added again for each start, and became very serious. Again, it was impossible to shut off current immediately; there were moving parts in the motor of high momentum, and the multiplying action of the sheaves increased by so much the travel of the car. It was impossible, therefore, to make landings as accurately as with the hydraulic, in which the water could be shut off instantly. The result was that in high speed service the car went too far, or fell short of the landing; it had to be lowered or

started up again, and this materially increased the energy consumed. He said that he had been enabled to get the exact figures of coal consumption at the Postal Telegraph Building, and it was 7¾lb. of coal. How he got them, he was sorry to say, he was not at liberty to state, but he proposed to show by these figures that other buildings employing hydraulic elevators were giving the same or better service on much less fuel. Then followed statements based on this coal consumption, within his own experience, showing better economy. One special objection raised to the Sprague elevator was inability to anywhere nearly counterbalance, resulting in a constant dead load at all times. He stated that he had written Mr. Sprague since the last meeting, asking him to publish his figures before the meeting, or at least to give them to him, so as to enable him to reply to them, but had received the reply that he (Sprague) would present such figures as he cared to present at the meeting.

Mr. Bolton followed, introducing his remarks by the statement that he at this time had 10 Sprague elevators under his charge, and that the figures given by Mr. Hutchinson were much better than Sprague had guaranteed to his principle when he had induced him to introduce the Sprague elevator. He questioned the accuracy of Mr. Hutchinson's figures for the elevator under working conditions, dwelt somewhat at length upon the merits and demerits of the old worm-geared electric elevator, and stated that he failed to see the difference between that and Sprague's device, except that in the latter the worm had grown a little longer and then, as worms sometimes do, had turned. The best efficiency of the screw was down in the 40s, and that was all that Sprague's elevator was—a screw elevator. It was not true, he said, as Sprague claimed, that where space was a desideratum the Sprague elevator would be installed, for it actually took up more space than did the hydraulic; and it was not true, as claimed, that the electric elevator was more economical than the hydraulic.

Mr. Eilder, the electrician of the Otis Company, stated that the drum machine had less than half the duty of the screw machine, and explained this partially by the possibility of overbalancing, or over-counterbalancing, the drum, and the impossibility of doing it with the Sprague.

Mr. H. Ward Leonard stated that he found himself in a somewhat peculiar position. He thought too much was claimed by Sprague, and also too much by the hydraulic people. He was convinced, however, of the superiority of the electric system, provided the right system was employed. He then enunciated the requirements of an ideal elevator, and pointed out that his own system met these requirements.

Mr. Holmes stated that there were two objections to the electrical elevator. First, that it took the motor on its weak points, requiring 200 per cent. of energy to start it in excess of its running requirements, and second, the Sprague elevator did not permit of overweight. The hydraulic elevator also had its weak points. It was weak, however, where the electric elevator was strong, and he believed that the proper solution of the question would be found in a combination of the two.

Mr. Hutchinson arose at this point, and asked Mr. Leonard's permission to quote some figures from a test of his (Leonard's) system made at the Otis factory.

Mr. Leonard stated that so long as it was understood that the arrangement there tested was not what he advocated, he had no objection whatever. Mr. Eilder also gave him permission to quote any figures he chose.

Mr. Hutchinson then stated that in these tests of the Leonard system it took 14 amperes at 220 volts to run the motors alone while the car was stationary, while to run the car it took 30 amperes, and to start it 35—40 amperes. The energy returned was from 15 to 45 per cent.

It was already quite late when Mr. Frank J. Sprague arose to reply, and with an armful of documents walked to the front of the audience. He began to speak with considerable feeling, saying that the dishonourable charge by Mr. Hill that he was running an exhibition plant and publishing results that were "cooked up" was one that no *gentleman* would make against a member of the Institute.

The President here brought down his gavel, and

Mr. Sprague repressed further outward manifestations of indignation. He said that Mr. Hill had rather dramatically announced that by some occult means he had procured the data of coal consumption at the Postal Telegraph Building, and had based upon the figures given a most elaborate argument to prove the inefficiency of the apparatus. There was no secret as to the coal consumption, and if Mr. Hill had desired, he could have gotten it without trouble. He himself "had asked for the figures that afternoon, and (holding up a blotter) here—a complete log of the coal consumption in that building." This record showed that the average consumption of coal was 6·2 lbs., instead of 7¾ lbs., as given by Mr. Hill. As regards the tests of his elevators in that building, any one was at perfect liberty to make them, so far as he personally was concerned. It must not be expected, however, that the owners of the building would consent to having Tom, Dick, and Harry interrupt their service whenever it suited their convenience to make a test. The statement had been made that it now takes 200 per cent. more power to start the car than was required when running. This had been true with some of his earlier experiments, but with the latter apparatus it could be done with not to exceed 50 per cent. over the running current. A great deal had been said by his critics in favour of the drum winding. As a matter of fact, the drum winding was 40 years old, and during that 40 years the hydraulic elevator men had never considered it as a competitor. Not until his own elevator came into the field did they consider it necessary to bestir themselves to do better than they had been doing. It was, in fact, the strongest possible recommendation of the Pratt-Sprague electric elevator that the hydraulic promoters deemed it necessary to make a united and concerted attack upon it.

AN EXPERIMENTAL STUDY OF BELT-LACING.*

By WALTER FLINT, M.E.

Every one who has had the care of belting has always had a decided preference for some particular form of lacing, and no doubt has ever existed in his mind that it was the best.

It is the object of this paper to demonstrate, so far as possible, which of the most common joints is the strongest, *the question of wear not being considered.*

Another point to be determined is the efficiency of the round-punched holes compared with the narrow slit cut with a belt awl. It is claimed by many practical men that holes made with the awl are better, because none of the leather is removed. Good reasons for doubting this theory have appeared, but no actual proof has been presented.

In making these tests 4-inch belting was selected and laced thoroughly with ¼-inch lacing, well stretched. Five holes were punched ¾-inch from the end for a single row of holes, and for a double row of holes the second row was 1½ inches from the end. The punched holes were $\frac{3}{16}$-inch diameter. These five holes removed $\frac{15}{16}$-inch from the width of the belt. The belt being 4 inches wide, the net section is about 76 per cent. of the solid belt, while in the cases where the holes were cut with an awl the net section is theoretically about the same as the solid belt.

The apparatus for holding the specimens was so constructed that the belt was free to move as though it were on pulleys, thus equalising the strain in that direction. It was then held in the testing machine by hooks, which allowed it to stretch more on one side than the other if it wanted to. This latter condition is not strictly true of a belt on pulleys, but considering the very short length of the samples it was thought best to have it so.

No. 1 and 1A.

The form of this joint is plainly shown in cut No. 1, and No. 1*a*, shows the break. The belt was not injured. The lace broke in the middle first and then on the edge. The joint failed under a tension of 1,150 lbs.

Since the net section should hold about 2,065 lbs., it is clear that more lacing should be put in.

No. 2.

This is the same form of joint as No. 1, except that the holes were made with an awl. It was not thought worth

* *American Machinist.*

while to photograph this one before testing. It will be noticed that the lace cut the belt from the holes in various directions. The lace did not fail till after the belt failed on the lower side.

The joint failed at 790 lbs., and the form of the break shows that the failure was due to the form of holes rather than weakness of belt.

No. 3 and 3A.

Same number of holes and punched same as No. 1, but double laced, as shown in cut No. 3. The break is shown in cut No. 3A at *c*. The lace was not broken.

Tension applied, 1,460 lbs.

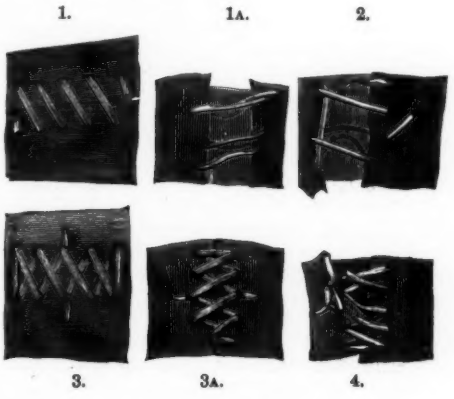
No. 4.

Exactly the same as No. 2, except that it was double laced as No. 3.

Tension applied, 1,335 lbs.

It failed by the lace cutting through the belt. Shape of holes was cause of failure. The lace was not injured.

These tests would seem to show that holes cut with an awl are far inferior to punched holes.



No. 5 and 5A.

This was a trial of one of the metallic fastenings. The fastenings being 1 inch long, the holes had to be made ½ inch from the end of belt.

No. 5A shows the broken joint.

Tension applied, 725 lbs.

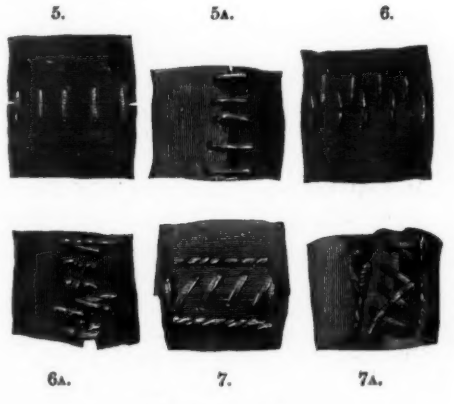
Two of the hooks broke, one straightened out, one pulled through the belt, and one remained sound, thus showing failure of both belt and fastenings.

No. 6 and 6A.

Same as No. 5, except that by staggering the holes four more hooks were put in.

No. 6A shows the broken joint which failed under a tension of 1,480 lbs.

Both belt and fastenings failed.



No. 7 and 7A.

Cut No. 7 shows this form of joint. Holes punched. The break is shown in 7A, and took place at 1,510 lbs.

The lace failed in one place, while the belt failed generally.

No. 8 and 8A.

This is known as the "boot leg" lacing, and is a great favourite in eastern Maine, because of its durability. Of course, it cannot be used used with a tightener nor in many other places.

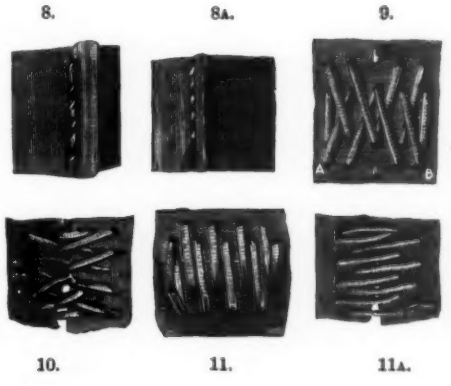
No. 8A shows the break which occurred in the lace; the belt itself had started to tear in several places on the inside.

Tension applied, 1,310 lbs.

No. 9.

This is a double-laced joint with only one strand in each hole. Holes punched. The negative of the broken specimen was lost, but the break occurred along the line A, B. The lace was not injured. As near as could be observed the break was simultaneous along A, B.

Tension applied, 2,015 lbs.



The net section of belt should have held about 2,065 lbs. This would seem to show that nothing further can be obtained when five $\frac{3}{16}$-inch holes are used, since the lace held more than the belt.

No. 10.

Same as No. 9, except that holes were cut with an awl. It was thought since No. 9 failed on account of too small a net section, that by making holes with an awl might possibly help matters. The cut shows the result. The lace was not injured.

Tension applied, 1,590 lbs.

No. 11 and 11A.

No. 11 is peculiar in that the holes are staggered, one strand in each hole, and strands not crossing on either side. There appears to be no reason why it should not hold as much as No. 9. The lace was evidently faulty, since the holes did not appear particularly strained. No. 11A shows the broken lace on the lower side.

Tension applied, 1,835 lbs.

This comes the nearest to No. 9 in strength.

ELECTRICITY DIRECT FROM CARBON.*

By Dr. ALFRED COEHN.

The problem of the direct production of electricity from carbon would find its simplest solution, if we could succeed in dissolving carbon in a fluid, just as we do metals. This question is formulated thus by the theory of electrolysis: Can carbon form ions?

In attempting to find an answer to this question, I started from an observation made by Bartoli and Papasogli, that when dilute sulphuric acid was electrolysed between carbon

* Angelegenheiten des Electrotechnischen Ucreins; Elect. tech. Zeit., March 19th, 1896, p. 190.

electrodes, the carbon anode takes part in the electrolytic processes in such a way, that besides oxygen, both carbonic oxide and carbonic acid make their appearance at the anode. I commenced my experiments by varying the important factors, viz., concentration, temperature, and current density, in order to discover whether it was possible to obtain the products of combustion without admixture of oxygen on the anode. I have not succeeded in obtaining carbonic acid or carbonic oxide alone, but a mixture of the two, containing only 1 per cent. of oxygen. In this mixture about 70 per cent. was carbonic acid and 30 per cent. carbonic oxide.

In these experiments it was observed that at low temperatures a disintegration of the carbon anode took place, small particles of carbon being seen suspended in the acid. At higher temperatures, on the contrary, no such disintegration of the carbon took place, but a distinct colouration of the acid was produced—at first yellow, then later, dark red and red brown. If this is a solution of the carbon brought about by the current, the carbon is presumably contained in it, in the form of ions, *i.e.*, in a form capable of being influenced by the directing power of the current. Such a solution must be capable of giving up carbon to the cathode, since carbon does not decompose water. (A series of platinum plates, coated with carbon, was shown, and a dish, such as is used by Classen for quantitative electrolytic analysis, was shown coated inside with a dense layer of carbon.) The solution and precipitation could readily be obtained with different kinds of coal as anode. Ordinary coal ground smooth, and arc lamp carbons, were found specially suitable; the experiment also succeeded with coke.

That the precipitate was really carbon, and not metal derived from impurities in the coal, was shown by treatment with acids. It was not attacked by hydrochloric acid; in hot nitric acid traces were dissolved—as in the colorimetric test for carbon in steel. In the flame, even the densest precipates completely disappeared immediately. Finally, a direct proof was obtained by oxidising the precipitated carbon by chromic acid, and absorbing the resulting carbonic acid in alkali. A number of analyses were made, and these always showed, in addition to carbon, a little hydrogen. The residue—reckoned as oxygen—was sufficient to convert the hydrogen found into water. Either, therefore, in addition to the carbon, a solid, conducting carbohydrate was separated, or some kind of crystalline water which adhered strongly to the carbon, was produced. The presence of water in the precipitate is indicated by its behaviour with concentrated sulphuric acid. If the acid is dropped on the precipitate it is immediately loosened and blackened, reminding one of the behaviour of sulphuric acid with a carbohydrate.

It was now of interest to attempt to construct an element whose soluble electrode consisted of carbon. The only question now was to place a more electro-negative element opposite the carbon. The peroxides stand still nearer even than carbon to the negative end of the potential series. Lead peroxide was used in the practical form of a charged accumulator plate. If this is placed opposite a carbon in sulphuric acid of the proper concentration, temperature, &c., an element is formed of which carbon is the soluble electrode. The element supplies a strong and constant current. Through an external resistance of 100 ohms it shows an E.M.F. of 1·03 volt.

There arises here the question whether any share in the production of the current is due to the reactions on the carbon, and if so, what share? Platinum also, when placed opposite a peroxide plate under the same conditions, shows a current in the same direction as the carbon. But it never comes to a visible development of oxygen; as soon as the platinum is charged with oxygen, the current becomes exceedingly small. If the carbon was an insoluble electrode, it would behave in the same way. But this is not the case. The current lasts till the accumulator plate is discharged. A second charged peroxide plate may then be substituted, and the current is again produced as strong as before.

The results of my investigation may be summarised as follows:—

1. It is possible by electrolysis to produce a solution of carbon.

2. From such a solution, carbon may be separated as a cation.

3. An element may be formed of which carbon is the soluble electrode.

SUBTERRANEAN TELEGRAPH LINES.

The *Globe*, of Tuesday, March 24th, publishes an article inspired by Mr. G. von Chauvin, of the Western Union Company, on the subject of "Our Telegraphic System: A Plea for Subterranean Cables," and in the same paper appears a short leader summarising Mr. von Chauvin's suggestions. Both article and leader are written in a satisfactory style, and the leader, for a wonder, does not contain any of the absurd deductions so characteristic of newspapers when discoursing on subjects of which they know only the elements. Mr. von Chauvin's suggestions contain, doubtless, a great amount of truth in them, but they do not contain the whole truth, and we think that they are calculated, to some extent, to mislead. The breakdowns, and consequent disorganisation to business which take place after heavy gales and snowstorms are far more numerous than is advisable, and, says Mr. von Chauvin, "sooner or later some trunk system of underground lines will have to be taken in hand by the Government if we are to maintain our commercial telegraphic supremacy." It is not at all clear whether Mr. von Chauvin asks for an exclusive trunk underground system, or for a mixed overhead and underground one; the general public will doubtless be clamorous for, and assume, that an exclusive underground system is meant, quite oblivious of the fact that such a system would render fast-speed working and telephonic communication an impossibility. Fast-speed Wheatstone working is a characteristic of our English system, and it can only be carried out effectually with overhead wires on account, of course, of their low electrostatic capacity. For the same reason, long telephonic working can only be carried out with aerial wires. It was estimated some years ago that to construct a complete main trunk line underground system would cost six millions sterling; it is probable at the present day, with our experience of paper cables, that a similar system on the scale estimated for would cost considerably less than this, but in view of the expansion of the whole telegraphic arrangements of the country, the amount named might now be necessary for a complete system. Mr. von Chauvin's idea of having underground wires from London to serve the cables, might with advantage be adopted as a commencement, and could be carried out without difficulty, provided the financial question was settled; for the whole question is nothing more than one of finance; it would, however, necessitate more wires being employed than at present, as the traffic on those circuits now worked by the Wheatstone apparatus would be considerably reduced in volume, as a consequence of the reduction in speed at which the apparatus could work through the underground wires. If Parliament authorises the necessary expenditure, the thing can be done. It must not, however, be believed that the aerial system would be doomed; it would be so, doubtless, if electrostatic retardation were an innocuous element, but unfortunately it is not so; at the best an underground system would be only a supplementary one, though of its value there can be little doubt. We do not require to be reminded that Germany has a very complete system of main underground lines; fast speed working is practically unknown in that country, and the conditions are therefore different, but still, the fact that such an underground system has been established and has proved successful from a maintenance point of view is a great argument in its favour, and will weigh with the public. The article states that when "telegraphic intercourse with the Continent is suddenly suspended, this is invariably owing to a breakdown in the lines leading to the English coast." As a matter of fact we have reason for saying that this is untrue; the vast majority of interruptions are not due to faults on this side of the channel at all.

REVIEW.

Applied Magnetism. By J. A. Kingdon, B.A. London: H. Alabaster, Gatehouse & Co., 22, Paternoster Row.

The subject of the quantitative applications of magnetism in its modern aspects has not hitherto been systematically treated, or, at least, has not had a simple treatise devoted to its consideration. The study of magnetism has now become an exact science, with the result that quantitative results are now obtainable where formerly quali-

tative ones were only possible. There is, probably, no subject of interest to the electrician of which such hazy quantitative ideas exist amongst the great majority as upon the subject of magnetism. Problems relating to static and dynamic electricity may be worked out with comparative ease, and numerical values obtained, but with the exception of a few questions dealing with "unit magnetic poles" few students have any notion of treating the subject. Mr. Kingdon's book should do a great deal towards dispelling this ignorance, more especially as it is written in a very clear and systematic style. The arrangement of the two opening chapters is, we think, a mistake, *i.e.*, the order of the two should be reversed, as it is practically impossible to follow the explanations in the first chapter unless a portion, at least, of that contained in the second is grasped; for instance, in the first chapter the author defines a "mag" as the unit of magnetic flux, and says that it "is the same as a C.G.S. unit of magnetism, and as Faraday's line of magnetic force," but nothing is said to enlighten the reader as to what the C.G.S. unit of magnetism is until the second chapter is reached. An excellent feature in the book is the free use of numerical examples, which are a great help to the student.

Chapter III., dealing with "Magnetomotive Force of Current," is a good concentration of information which has hitherto existed in a rather scattered form, and Chapter IV., on "Tractive Force of Magnets and Current Reactions" shows that the calculation of tractive force is possible to a very fair degree of accuracy. The practical importance of the subject of applied magnetism, of course, comes out strongly in the subject of alternators, and this is dealt with in Chapter VII. Mr. Kingdon's treatment of the points considered might, with advantage, have been somewhat more extended.

Chapter IX., dealing with "Magnetic Leakage and Design of Magnets," is an important one, and does not very readily yield to mathematical analysis, but there is much valuable investigation given.

The book, generally, may be said to run through the whole gamut of the subject, both from a synthetic and from a practical point of view. In the concluding chapters various useful formulæ are given, and also a practical example of magnetic calculations for various parts of an alternator designed by the author. Altogether the book may be recommended as a necessary practical addition to the electrical engineer's library.

THE REGULATION OF PRESSURE AND THE REDUCTION OF LIGHT LOAD LOSSES IN ALTERNATING CURRENT SYSTEMS OF ELECTRIC SUPPLY.*

By E. W. COWAN, Member of Council, and ALFRED STILL, Member.

On account of the greater facility with which the pressure can be maintained on a system of distribution when the supply is a high tension one, provision for its regulation has come to be somewhat neglected in this country. The standard of permissible variation of pressure with a low tension system has not been a high one, and because with a high tension supply it has been found easy to improve upon this, few efforts have been made towards the attainment of a higher standard. But with the heavier loads of to-day, and the advantage of our more complete knowledge of alternating currents, we should not rest satisfied with so low a standard; and complaints from consumers connected to the tail end of long distributors of the falling off in their light at times of heavy load when its full brilliance is most desired, should belong to the history of the past. We can do better, and we ought to.

The object of the first part of this paper is to set forth what we believe to be the best methods of maintaining constant pressure in all parts of a distribution system under varying conditions of load.

The first point to which attention must naturally be paid, is the arrangement of the mains and transformers. This subject has already been dealt with to some extent before this Society by Mr. Clirehugh and Mr. Rider, but as each district must be considered on its own merits, it is not possible to formulate any definite rules. There are, perhaps, four systems open to us:—

1. High tension distributors with transformers on consumer's premises.

2. Feeders in connection with high tension distributors, and transformers on consumer's premises.

3. Feeders with transformers in sub-stations and low pressure distribution.

4. Feeders with transformers in street boxes, and both high and low tension distributors.

From the point of view of the subject of this paper, viz., the regulation of pressure, the first of the above systems is the worst, and the last one the best. It is on the relative advantages of the third and fourth systems that we should like to offer a few remarks.

Sub-stations with banks of transformers have become very popular; but we are inclined to think that their advantages are somewhat overrated, and that a cheaper, and in some respects more efficient arrangement, is to space out the transformers under the footway in the manner indicated at D, in diagram No. 1. With this arrangement a much better regulation can be obtained than the low pressure distribution system shown at C. It has the further advantage of simplicity in the first laying of the mains when the distribution of the load is uncertain. Most of us have been surprised when a station has been running for some time to find that our lamp connections have not distributed themselves according to our expectations, and that we have heavy cables lightly loaded, and light cables heavily loaded. With this system it is simple and inexpensive to lay both high and low tension cables of large enough capacity for the ultimate requirements of the district. The transformers, which may be of uniform size, are fixed according to the position and amount of load as it arises; the final result being that transformers are close together where the load is heavy, and comparatively remote in those positions where the demand is small. It may be argued that many transformers of a small size cannot be so efficient as a small number of larger size; but 12 to 15 kilowatt transformers may have a very high efficiency, and they are more readily handled than the very large sizes often fixed in sub-stations.

If underground switches are arranged to connect the low tension service mains of one transformer to those of the transformers on each side of it when required, it will be possible to remove a transformer without interfering with the supply. And if similar switches are fitted at intervals in the high tension main, a fault in the cable can readily be cut out and the supply continued in the whole district fed by this main, with the exception of the particular length which contains the fault. Such underground switches can be made at a low cost, and will work quite satisfactorily.

Whatever system may be adopted, it is certain that feeders will form part of it, and the important question arises as to what cross section they should have. Apart from the question of regulation, there can be no doubt that they should be proportioned in accordance with Thomson's law; but here a difficulty arises—the loss of pressure will frequently be so great that, at times of full load, uniformity of pressure cannot be maintained at the feeding points unless all the feeders are of the same length and subject to corresponding fluctuations of load; a condition which does not obtain in practice. It follows, therefore, that a regulating device must be connected to each feeder, preferably at the generating station end, or inequality of pressure at the feeding points will result; the other alternative being to lay feeders, which are uneconomical on account of their large cross section and corresponding first cost. Mr. Crompton, we think, makes too much of "Efficiency of Distribution;" this being a question which cannot be properly dealt with, except in connection with first cost.

We propose now to describe a simple graphic method of determining the sectional area of feeders, according to Thomson's law, as the usual formula needs some modification to adapt it to cables of which the insulation bears a large proportion to the total cost, and which do not carry a constant load. We will afterwards deal with the various regulating devices which are available at the present time for compensating for the drop on the feeders.

Feeders.—The most economical cross section for a feeder depends upon two things only: the first cost of the cable, and the cost of production of the energy lost in it on account of its ohmic resistance.

Thomson's law, which takes into account the annual cost of the watts lost in the conductor, and the allowance for depreciation and interest on first cost of the cable, may be expressed as follows:—

The most economical section of a conductor supplying electric current to a distance is such, that the annual allowance for interest and depreciation on original cost of the cable will be equal to the annual cost of the energy wasted in overcoming its ohmic resistance. The cross section should therefore be determined solely by the current which it has to carry, and not by its length, or an arbitrary limit of the percentage full load drop in pressure—the drop, even if considerable (and it is not likely to be so on a high tension system), must take care of itself.

There are possibly two reasons why Thomson's law is not more generally followed in calculating the sizes of feeders for systems of electric light supply:—

Firstly—because it applies only to bare conductors, of which the cost per mile may be taken as being proportional to the weight of the copper, and therefore to the cross sectional area; and secondly, because it assumes the current to be constant from one year's end to the other; a condition of things which unfortunately has not been realised by electric supply stations. Although Thomson's law, in its usual form, is not directly applicable to existing conditions, the *spirit* of it should never be deliberately neglected. All that we have to attend to is this:—to see that annual cost of the energy wasted in a mile of the feeder, added to the annual allowance (per mile) for depreciation and interest on first cost, shall be a minimum. With regard to the question of varying current, this is easily dealt with. The energy lost in a given cable depends upon the square of the current, and the time during which the current is flowing. If a cable conveys a current, C, only 12 hours out of the 24 hours, then the energy wasted per day is only half what it would have been had the

* Paper read before the Northern Society of Electrical Engineers, March 23rd, 1896.

current been flowing continuously, and the watt hours may be expressed as $12 \times C^2 \times r$, or as $24 \times \frac{1}{2} C^2 \times r$, and it is evident that in working out the energy lost per annum in the cable, we have to multiply the resistance, not by the square of the *maximum* current which the cable will carry, but by the mean value of the squares of the current during the year.

From measurements taken on actual load diagrams, it would appear that, in the case of electric light supply stations having a small all-day load, the full load or maximum current is from two to three times as great as the mean square value of the current taken for the whole year; this proportion depending upon whether the capacity of the feeder is appreciable or not, and also upon the nature of the districts supplied. It is evident that this multiplier can easily be worked out from a few typical load diagrams.

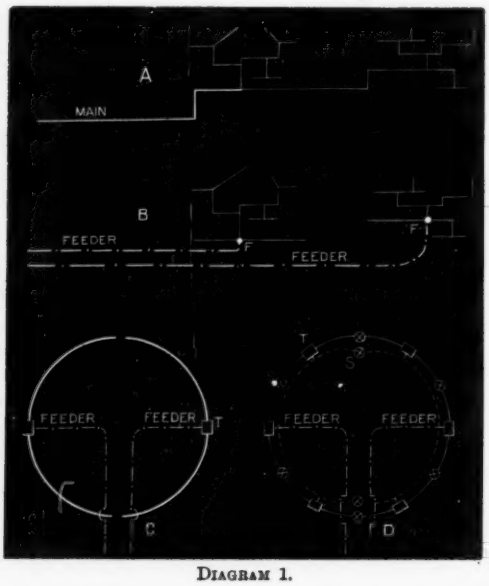


Diagram 1.

The following example and the diagram, fig. 2, will make it clear how the proper size of cable may be worked out in actual practice; and, first, it should be understood that it is the cost of the cable only on which the percentage for interest and depreciation should be taken, because the cost of trenching and laying, or drawing into pipes or culverts will be practically constant, and unaffected by the exact cross section of the copper in the cable. Let us suppose that 10 per cent. is to be allowed for depreciation and interest on capital spent; then, in the diagram No. 2, where the horizontal distances re-

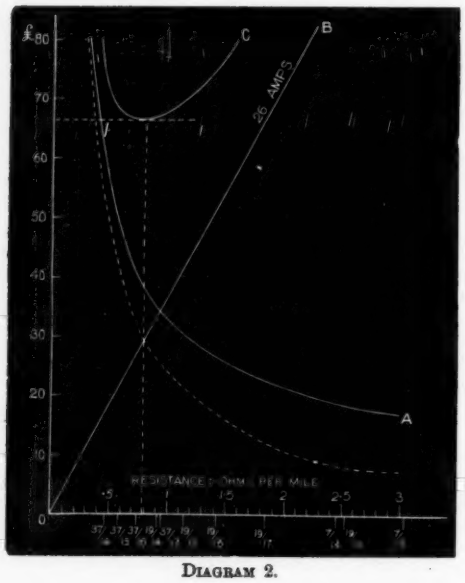


Diagram 2.

present resistance in ohms, and the vertical distances represent money, plot the curve, A, which gives the relation between 10 per cent. of the cost per mile of the cable (taken from the maker's price list) and its resistance in ohms per mile (go and return)—this curve, which has been plotted from actual prices for concentric cables by a certain firm of well-known manufacturers is not a rectangular hyperbola, as it would be, if Thomson's law were to hold good. The dotted curve is a true hyperbola, or the curve which makes the cost universally proportional to the resistance of the cable, and inspection of these two curves will show how the cost of the (insulated) cable is proportionately greater for the smaller sizes.

Now, calculate the cost of the $C^2 B$ losses per mile of cable for any particular value of the resistance, and draw the straight line, O B, which will give us this cost for any other resistance of cable. In this diagram the losses have been calculated on the assumption that the current is 26 amperes, and that the cost of production is 1½d. per unit. It is evident that this must be taken on the low side, as during the life time of the cables, the works cost per unit may be expected to be reduced.

By adding the ordinates of the curves, A and B, the curve, C, is obtained, whose minimum value corresponds with a resistance per mile of ·78 ohm. The nearest cable to this (on the small side) is 19/14, and this if the cost of production of electrical energy, and the probable current have been estimated correctly, is the proper size of cable to use, whatever may be its length, or the voltage required at the feeding point.

Assuming the maximum value of the current to be three times the square root of the mean square value, and the length of the feeder to be one mile, the "drop" at full load would be:—$78 \times 91 = 71$ volts.

Capacity.—The effect of capacity in a system of concentric mains is to increase the current entering the cable at the alternator end, although the current leaving the cable at the far end will of course depend only on the pressure and lamp load at that end.

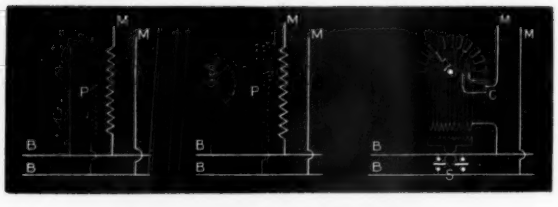
In the long concentric feeders the capacity current should therefore be taken into account, especially as its effect in increasing the total current is more marked at light load than at full load. It is easily calculated with sufficient accuracy by the formula $C = 2 \pi n K V$.

Where K = the capacity in Farads.
n = the frequency in periods per second.
V = the mean voltage.

It must be remembered that this current is not in phase with the main current but ¼ period in advance of the impressed volts.

Hence if $c = 10$ amps. this will be the current indicated by the feeder ammeter on open circuit. At full load with 60 amps. taken out at the far end, the current read on station ammeter will be the square root of $60^2 + 10^2$ or about 61 amps.

Fig. 1.—Gordon. Fig. 2.—Kapp. Fig. 3.—Stillwell.



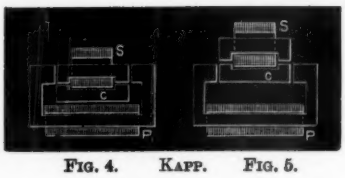


Fig. 4. Kapp. Fig. 5.

Diagram 3.

The following capacities of concentric cables have been kindly furnished us by the makers, and may be found useful in estimating the probable value of the capacity current in a given system of mains.

Capacities per mile (inner to outer) of 19/18 concentric cables:—
British Insulated Wire Company (paper) ... ·31 microfarads
Glover and Company (vulcanised rubber) ... ·615 "
" " (Diatrine) ... ... ·315 "

Drop on Feeders.—Having fixed the cross section of the feeders and calculated the full load "drop," it will generally be found that the latter is considerable on the long feeders and inappreciable on the short. Some methods of dealing with this difficulty must therefore be adopted which will allow of each feeder being independently regulated, as, if we raise the pressure of the bus bars to compensate for the drop on the long or heavily loaded feeders we shall be at the same time increasing the pressure at the feeding points which are nearer the generating station or at those which are more lightly loaded. There are three methods of effecting the desired result, all equally efficient in respect to regulation, but differing widely in their efficiency in respect to economy.

1. Raise pressure of generators until bus bar pressure equals that required for the feeder with the largest drop, and switch more or less resistance into all the other feeders to absorb the consequent excess of pressure above that required.

2. Same as above, but use variable choking coils instead of resistances.

3. Adjust pressure of generators until bus bar pressure equals that required for the feeder with the least drop, and by means of a special induction apparatus add pressure as required to the remaining feeders.

Very few words will be required to show the great economical advantage of the third method over the two others.

In the first plan the resistances dissipate energy which has cost fuel to produce, and so rob the station of a percentage of its output at the time of maximum load: a serious disadvantage in itself.

The second plan is much more economical than the first. But choking coils are not like transformers—the induction and consequent loss in the iron being very much higher on account of the E.M.F. of self-induction being ¼ period out of phase with the main current. For a 10 per cent. reduction of pressure the amount of the induced volts will be over four times the volts deducted. But apart from this it will be readily seen that the generation of the E.M.F. by the dynamo and its subsequent destruction by the choking coils cannot be an economical arrangement, accompanied as it must be by the losses of a double operation.

The third plan is free from the above objections—the volts required to compensate for drop are added when and where required, and the generators, being worked at a low pressure, work more economically. Without analysing the question, common sense tells us that such a plan is better engineering. When we want to light a part of a building, we do not think it right to switch on all the lamps and screen the light from those parts not needing illumination, and there is no more reason for regulating feeders upon a similar principle.

The use of a regulating transformer for this purpose was first brought under our notice by Mr. J. H. Rider, who designed and specified such an arrangement for the Bolton Corporation electricity supply station. The principle was not, however, new, and it may be of some interest to trace its development.

As far as we have been able to ascertain, the late Mr. J. E. H. Gordon was the first to make use of the idea of augmenting the E.M.F. of a circuit by connecting in series with it the secondary coil of a shunt transformer. In diagram No. 3 this plan is illustrated. He termed the apparatus a "hitcher-up." Fig. 2 on the same diagram shows a feeder regulator designed by Mr. Gisbert Kapp; this apparatus is the same as Gordon's, but is provided with a means of varying the augmentation. A segment switch is arranged to cut out the primary coils as desired; as the coils are cut out, the E.M.F. generated in the secondary is, of course, increased.

Fig. 3, diagram 3, shows the principle of an apparatus designed by Stillwell, in America, and manufactured by the Westinghouse Company. This design is similar to Kapp's, and was, indeed, also suggested by him, the only difference being that instead of primary coils being cut out secondary coils are switched in.

Figs. 4 and 5 at the bottom of the diagram illustrate another design of Mr. Kapp's, which was intended to get over the difficulties of a high tension segment switch, with its necessary devices, to avoid short-circuiting a coil when being moved from one segment to another, and also to get over the objection of the additions to the voltage taking place in jumps, the necessary result of using a segment switch. The principle of its action is entirely different to the others, the variation in effect being obtained by a movement of the iron core. Fig. 4 shows the apparatus in the position of maximum effect, the magnetism created by the primary coil cutting the secondary coil. In fig. 5 the core and secondary coil are removed to the position of no effect, the magnetic lines flowing along the core, c, outside the secondary winding, instead of through it. We are not aware that this regulator was ever made; it is perhaps scarcely fair to criticise it, but it is apparent that in the position shown in fig. 5, the self-induction of the secondary would result in a serious loss of pressure in the feeder, and in the position shown in fig. 5, the magnetic leakage would be appalling.

(*To be continued.*)

CORRESPONDENCE.

High Voltage Lamps.

In your last issue of March 13th, in the paper read before the Institution of the Electrical Engineers by Mr. G. L. Addenbrooke, member, on "High Voltage Lamps and their Influence on Central Station Practice," at the bottom of the 359th page, "Effect of Using High Voltage Lamps on Distribution," there is the assumption that by increasing the voltage the progress shall be of the cube of the increase, or doubling it, as it is the present case, we shall have an area 16 times more than before at the disposal of the station.

If I mistake not, it is true that we can do four times the lighting with the same mains, but it is only if we remain in the same area. As soon as we depart from such an area the things shall be not as described, because the cost of the mains for having the same *total* resistance will increase as the square of the length, so that the cost of two miles of main (the copper) of, for instance, 1 ohm of *total* resistance, will be four times the price of a main of the same resistance, but only a mile in length.

In the same way, if we will do the same amount of lighting at four times the distance, with the same percentage loss, by increasing to double the voltage at the station, we can do it, but we shall employ four miles of main in place of one, and the main cost shall be four times as before, which is inconsistent with the actual ledger at the central stations.

But if we will only double the length of the main, we can, with the same percentage loss, diminish its size to a half, and in such a case, the copper expense shall be the same as it was with half the voltage at half the distance.

So it is apparent that, doubling the voltage, we can only double the distance at which we may supply the light, with the same percentage loss, and the same main expenditure for light unit; and the surface supplied will be four times only as before.

Apologising for my little knowledge of your language, and for having presumed you will insert this remark,

G. T.

Vicenza, *March 17th*, 1896.

Superheating.

I am glad to see that you call attention in your paper, No. 955, to some observations published in the *Engineer*, on Mr. Patchell's paper on "Superheating."

When I wrote the criticism in question, I did *not* intend it for publication, but simply as a hint to the Editor in case he gave another editorial on the paper. Instead of this, the Editor published my letter to him with several errors, arising, I presume, from illegibility, it having been written in great haste on the spur of the moment, just after having read the abstract of Patchell's paper in the *Engineer*. I must confess I was somewhat irritated, having read previously in some technical paper that Mr. P.'s paper went to show how the output of our boilers could be increased three times; and when it turned out that the output at its maximum was only 3·6 lbs. per square foot, such a miserable showing is, I submit, sufficient to rouse one's ire.

You remark that my "comments are misleading." I fail to see the point of your remark; my comments are as clear and to the point as possible.

You also remark that I "overlook the fact that the smaller rate of evaporation per square foot does not necessarily imply a smaller rate of evaporation per square foot of floor space occupied." I am perfectly aware of this, but there are, I think, boilers which are superior to the water tube boilers in this respect—the Scotch marine and some of the American vertical types, for example.

You also make the very gratuitous assumption that "I evidently think that adding heating surface to a boiler will add to its evaporation, quite irrespective of the grate area." This is entirely gratuitous, I said nothing which would commit me to such an absurdity. You give a boiler maker like myself, of some 50 years' standing, very little credit for common sense.

At the conclusion of your remarks, you suggest that "it is quite possible that at high rates of combustion the action in the inclined tubes of a water-tube boiler will be much improved."

My experience shows that no improvement in the action of the inclined tubes results from higher rates of combustion; on the contrary, the tubes bend and begin to leak at the headings, steam pockets form, and the tubes rip open.

This serves to show that there is something radically wrong in boilers of the Babcock type, they are only to be tolerated in such cases where the output per unity of heating surface is very low, and in my opinion such boilers have no *raison d'être* commercially.

The value of a boiler depends on what duty can be got out of it in regular work, with fair economy and dry steam, and without interruption over long periods.

C. Brown.

Basel, *March 18th*, 1896.

P.S.—Experiments are now in progress which show that the production of steam per unity of surface may be very materially increased, and this with fair economy and without fatiguing the materials.

Central Station Working.

Referring to the comments in your issue of February 28th upon the writer's contribution to a series of articles appearing in the *Electrical World*, of New York, on the subject of "Central Station Working," I beg to call your attention to a couple of misleading statements contained therein.

In the first place, though this is not vitally important, the writer is not now "in charge of a combined steam and water-power station," and the station referred to is not at present operated with "a common countershaft and one unit to supply all the energy," as you imply. My article definitely stated that the original plant was built several years ago, and was soon afterward changed over in the manner described. The article also stated that an absorption regulator was *designed*, but rendered unnecessary by reason of the changes made in the plant; your comment refers to the matter as though the failure of the regulator were the cause of the changing of the station. As a matter of fact, the governor worked with entire satisfaction for a week or 10 days prior to the change in the plant, but the period of service was so insignificant, that mention of it was omitted.

Trusting that you will not object to giving this communication space in your valued journal,

Cecil P. Poole,
Associate Editor, the Electrical World.

New York, *March 13th*, 1896.

The Paper Machine a Generator of Electricity.

I intended calling your attention to the uselessness of earthing, but it slipped my memory last week. As your correspondent has not been answered, I would suggest a good condenser of a suitable capacity, well insulated from earth, with a suitable arrangement to discharge. The electricity is static, not dynamic; therefore it is no use of putting to earth. Any electrician who understands static effect should be able to carry out such.

E. Hancock.

Cardiff, *March 21st*, 1896.

[Mr. Hancock may perhaps glean some useful information as to the utility of "earthing" from one of our Notes bearing upon this subject.—Eds. Elec. Rev.]

Concentric Cables v. Bare Strip.

We seem to be making progress in this discussion about jointing on above, and have dislodged your anti-vivisectionist contributor from the position of "absolute impossibility" in regard to jointing on live concentric cables. Though he has taken shelter behind the "utterly impracticable," he will find this, too, is but a shadow when the sun rises a bit higher, and he realises that the operation he thus characterises is mere routine work with concentric people. We are all familiar in engineering history with the tragic chorus of philosophers predicting disaster which once was inseparable from every departure from the beaten track, but these Jeremiahs subsided in the presence of a *fait accompli*. Your contributor, however, reminds us more of those wise men of Box, who declared that to tunnel under the Moor was "utterly impracticable"; then when the tunnel was made, that it was only "courting disaster" to travel through it, and consequently always took coach over the hill, and joined the train on the other side. That coach is no longer remunerative.

Of course, if the jointer's hands would "almost certainly slip" in cutting into a cable, we are discussing a question already begged. I could equally assert that to bring crowbars, picks, shovels, spanners, &c., near a culvert containing bare strip was "almost certain" to result in a short circuit, if current was passing, and with just as good grounds. But I know the bare strip people are so wise and careful that nothing of the kind can ever happen. In fact, I begin to doubt if current would be so ill-behaved as to take advantage of a spanner laid across the bare conductors.

As to the concentric problem, even quite "ordinary jointers" are aware that there is surplus wire to remove from the outers for clamped connections, and instead of the cable presenting the appearance of a chimney sweep's brush with bristles of wire 5 inches long, there are no free ends longer than 1 inch. The cross bars used in the sketch supplied are covered with tape, which is only removed when and where the house leads come on, and an accidental contact does no harm. No such contact could be made by the wires in any case. Your "practical readers" may breathe again.

A new question comes in at the tail of your contributor's letter—that of cost. This is another matter altogether, and I will only point out that the cost of a distributing system is not completely stated by figuring about house connections. When the whole cost is taken into consideration, I dare say concentric cable will make a very good case for itself as against strip in culverts. I may add that "my experience" leads me to believe that the cost of a connection to bare strip is not all summed up at "under half-a-crown."

In concluding my share of this correspondence, I desire to express my sense of the courtesy of your contributor in condescending to discuss a practice which stamps its followers as "culpable fools." There are not many wise men who will take so much pains to convince a fool, "culpable" or otherwise. My gratitude (and that of many others) is due to him.

J. H.

March 23rd, 1896.

I notice that one of your correspondents asserts that it is not practically possible to make a joint on a "live" concentric cable.

Will you allow me to say that it is not only possible, but easy with ordinary care on the part of an ordinary jointer.

If the joint is made on an alternating low pressure network, there is no need for "clamps" in most cases, as there will be a transformer at each end, and if the joint is made at times of light load, the ohmic drop is inappreciable.

It is idle discussing questions of *fact*, and I may therefore conclude by saying that it is within my own knowledge that it is done every day.

Geo. T. Pardoe.

March 23rd, 1896.

Electro-Therapeutics.

Would you kindly tell me the address of the publishers of the *Proceedings* of the Electro-Therapeutic Associations of America and Canada, or the addresses of their secretaries? I should like very much to have a good, reliable, up-to-date book on Electro-Therapeutics; also to know whether "Duchenne" of 1871, "Althaus" of 1873, "Beard and Rockwell" of 1875, are still to be considered as authorities? These books we have here. The applications of magnetism in medicine are especially interesting. If you would be so very kind as to give me this information I shall be extremely obliged.

W. B. Graham.

Loughborough.

[The addresses asked for by Mr. Graham and other correspondents are as follows:—The American Electro-Therapeutic Association, 17, West 43rd Street, New York City; National Society of Electro-Therapeutists, Boston (?). We would recommend Mr. Graham to read the book on "Medical Electricity," by W. E. Steavenson and H. Lewis Jones, in preference to the other books mentioned; these being over 20 years old cannot contain the latest practice in electro-therapeutics.—Eds. Elec. Rev.]

Re Electric Elevators.

We have no wish to intrude on your space with any further general discussion on this question, but must ask your permission to supply the correction invited by Mr. Gibson on a matter of fact. In your last issue Mr. Gibson seems to insinuate that we have attempted to mislead the public by referring in our letter of the 28th ult. to notices in the Cape and other papers of electric lifts when we had not completed any electric lift at the Cape. That this very rash statement is quite unfounded you will see by the enclosed extract from the *South African Telegraph* of November 23rd, 1895, which gives an account of a lift working in the premises of Messrs. Heynes & Mathews, in Cape Town, which was the first electric lift at work in the colony; and no doubt the satisfactory working of this installation has influenced other orders which we have since received. Further, on the 18th ult., the *Cape Times* of January 28th reached us, containing notice of our electric lift at the Royal Hotel, Cape Town, which is there stated to have been running successfully since the 18th of that month.

We are glad to be able to assure Mr. Gibson that his intelligence was not at fault when he understood that the 11

orders (now increased to 18) mentioned in our letter, were for electric lifts only, and we have no doubt that he was led away by what he considered indisputable information, or he would not have stooped to impugn the veracity of a competitor, at all events by implication, and we feel sure he will be the first to make the *amende honorable*.

We will not endeavour to turn your correspondence columns into a means of advertising the number of hydraulic and other lifts we have made and have in hand, but shall be glad to show any of your readers, who will give us the opportunity, that as an English firm, we are capable of turning out the work, the quantity and quality of which we have no cause to be ashamed of.

For **R. Waygood & Co., Limited,**
D. W. R. Green, *Secretary.*

March 25th, 1896.

[The extract to which our correspondents refer was omitted.—Eds. Elec. Rev.]

Concentric Wiring.

Mr. Allingham, in your current issue, asks how switches for controlling lamps from two or more points are arranged in concentric wiring. They are arranged as in double wiring, but with the difference that the cables are concentric, and the outer conductors, with their sheathing, terminate in the jointing pockets of the cast brass switch boxes. The 5 ampere Unique switch, which is largely used with our concentric wiring, is well adapted, and is often employed for the purpose in question, a third hole being drilled in the cast brass box to admit the extra conductor.

Sam Mavor.

Glasgow.

The Lighting of Hospitals.

Would you kindly inform me, through the medium of your valuable paper, how many hospitals and infirmaries are lighted with electric light throughout the United Kingdom, and whether the majority use their own plant, or take their supply from an outside source?

Perhaps you can also inform me of the London hospitals which are lighted, and the approximate sums expended.

Statistician.

March 25th, 1896.

[There are many hospitals and infirmaries in this country lighted by electricity, the majority of which use their own plant, but we are not able to give the exact number. Perhaps some of our readers, who have made hospital lighting a speciality, may be able to help our correspondent.—Eds. Elec. Rev.]

AN ERROR IN DESIGN OF ELECTRICAL PLANT.

By W. H. BOOTH.

Electrical engineers are apt to pride themselves upon the uniformity of speed necessary in running electric light machinery as though no such steadiness had ever been obtained before. It is said that, whereas the eye has a range of vision of only about one octave, the ratio of vibration between the two extremes of the visible spectrum being only as 1 to 2, the ear has a range of several octaves, there being seven in an ordinary pianoforte keyboard, and these by no means exhausting the range of audible vibration. The ear is thus an instrument of greater sensibility than the eye. Yet it is often easy to detect the variation of light produced by the best electrical engines. On the other hand, a keen ear cannot detect any difference of tone in the hum of a roomful of many thousand spinning spindles, driven by one of the much abused mill type of engine in an ordinary modern mill, and this is certainly proof of regular turning. In rope driven dynamos where there is a sudden change of load, there is apt to be very serious oscillation of the ropes, and advocates of direct connected engines use this as an argument in favour of direct connection and in favour of high rotative speed of engine and against the mill engine. But they entirely overlook several most important facts. In the first place they do not know what a mill engine really is. The smallest mill engine now made for a modern mill will indicate 1,000 horse-power and possess a fly-wheel of great capacity. The so-called mill type of engine used in electrical lighting has, with few exceptions, been of small size, and when of large size, is there any instance of it having proved unsatisfactory? These small sized mill type of engine have small fly-wheel capacity and they are set to drive dynamos. Looked at from a mechanical engineers' point of view a dynamo is a very effective form of brake, and differs only from a friction brake in the retarding medium, which resembles the hydraulic brake in its action rather than a band brake. The revolving portion of most dynamos is of small mass and of small diameter. Even in alternators of larger diameter the revolving portion is not heavy. There is therefore but very little tendency in a dynamo to preserve a uniform speed of rotation. The armature opposes a resistance more or less uniform to the driving power of the engine and any change in its resistance is felt with full force by the medium which transmits the power from the engine to the dynamo pulley. Where this is a belt or ropes a sudden change of brake power must at once be made apparent in such flexible connectors. With direct connected engines the same cause is there, but the effect is not visible and engineers who employ direct connected engines have always taken the precaution of putting a fly-wheel between the dynamo and the point where the engine gives off its power.

There is no evidence whatever to show that they had the slightest suspicion that they were acting virtuously in so doing. The probable explanation is that having been brought up to consider a fly-wheel necessary upon an engine, they very properly applied it, and did not perceive that in so doing they had really applied one to the dynamo. If any engineer doubts the greater importance of a fly-wheel upon a dynamo than upon an engine let him couple the two by means of a shaft long enough to contain exactly similar breaking pieces on each side of the fly-wheel, and note how much oftener the break will occur upon that side next the dynamo than upon the engine side, when the load of the dynamo is varied considerably. However, the fly-wheel, survival of the fly-wheel actually necessary upon a Boulton and Watt beam engine at 17 revolutions per minute, was continued upon the high speed engine at 300 revolutions or more, and, no doubt, if it thought about the matter at all, it came to the conclusion that it was so placed upon the shaft with a view to controlling the irregular running of the piece which was exposed to the more sudden changes of energy, and it set itself to control the dynamo, though all the time it has been credited to the engine. True it might have been placed at the opposite end of the engine, and, had it been so placed, it would have protested in its own way against this faulty position by breaking the crank shaft with more than ordinary frequency. The so-called mill type of engine has never had a fair chance given it. Either it has been set to directly drive some light armature credited with being its own fly-wheel, or it has been compelled to drive what may be termed an electrical brake through the agency of a belt or ropes. No electrical engineer has yet had sufficient respect for the worn out and obsolete methods of fossil mechanical engineering to put a fly-wheel between the dynamo and the point where the power is given off by the engine. The fortuitous arrangement of a fly-wheel so placed in direct driving engines, has not appealed to them, because they have classed the fly-wheel with the engine where it was least needed, rather than with the dynamo which did require its services. Content to use boilers of no heat capacity, they have applied these morals to their dynamos and made these also without the necessary power of storing energy that is so obviously required. Is it then to be wondered that where there are sudden and wide variations in the demand upon the dynamo the effect so directly thrown upon the ropes should cause these to leap or oscillate in a manner that could not occur were there stored up close to the armature a quantity of energy ready for immediate use and available on the smallest change of rotative speed. Stated in plain English those engineers who drive dynamos with ropes and without fly-wheels, are expecting to get out of a few pounds weight of rope the effect of a massive fly-wheel. Needless to say, they don't get the desired effect, but is this faulty designing to be allowed to warrant

the bald statement that mill engines will not drive dynamos satisfactorily? Direct connected advocates are usually loudest in their condemnation of the mill engine, which is in itself proof that they are themselves unaware of the reason for the success of direct driving, or surely they would have pointed out where the fault really lay. It is true that mechanical engineers do not put fly-wheels on cotton machinery for the very good reasons that there is no variation in the resistance of cotton machinery and that it is essential that a machine should stop quickly upon the throwing off of the belt and start again with similar promptitude, neither of which desiderata could be attained with fly-wheels on the machines. But mechanical engineers do put fly-wheels on punching machines and shearing machines; they put them on chaff-cutters and on stone breakers, and it has been reserved for electrical engineers, who most need fly-wheel action in both boilers and machinery to discard this action or where employing it to do so by a mere fortuity.

In traction work especially there should be a fly-wheel upon every dynamo. It is not possible to transmit fly-wheel effects through elastic connections, and it is entirely opposed to all principles to run a lot of machinery from a central source without storage near the point of use when the demand is fluctuating.

BUSINESS NOTICES, &c.

Bankruptcy Proceedings.—At the last sitting of the Brentford County Court, before his honour Judge Bagshawe, Q.C., the examination of Mr. Herbert Reeves, one of the signatories of the articles of association of "Ronald A. Scott, Limited," was continued by Mr. Cecil Mercer, the official receiver. The examination was adjourned.

The statement of affairs filed under the recent failure of William Gray, jun., trading as the Scottish Electrical Engineering Company, at 52, Frederick Street, Edinburgh, shows liabilities amounting to £2,700, and the assets, after deducting the preferential creditors' claims, amount to £2,291.

Dissolution of Partnership.—Messrs. Charles Richardson and Edward G. Herbert, hitherto carrying on business as electrical engineers at Cornbrook Park Road, Manchester, under the style or firm of Richardson & Herbert, have dissolved partnership by mutual consent. Mr. Herbert, who will continue the business on his own account and in his own name, will also attend to the debts of the late firm.

Liquidation Notices.—At a meeting of the Coventry Electrical Engineering Company, Limited, at 17, Hertford Street, Coventry, on March 16th, it was resolved to wind up the company voluntarily, as it cannot, by reason of its liabilities, continue the business. Mr. S. T. Peirson was appointed liquidator.

Business Announcement.—Messrs. Ashton, Frost & Co., Limited, Engineers, Blackburn, have started a dynamo and motor department, and have engaged Mr. F. J. A. Matthews, formerly of the firm of Messrs. Rosling & Matthews, Bradford, to take charge of this department. We understand they intend building machines for the trade only.

Catalogues.—Mr. G. Braulik, of Upper Thames Street, E.C., has issued a new list of Messrs. Korting and Mathiesen's patent arc lamps and accessories. This is the third enlarged edition published within the last three years since the lamps have been on the English market. Various patterns of continuous current arc lamps are described and illustrated, as are also search lights and a number of patterns of covers for arc lamps. Supplementary lists of carbons, ammeters, and voltmeters are also before us. Copies of the lists may be obtained on application.

Messrs. Nalder Bros. & Co. are now issuing a price list of new patented brass-cased ammeters and voltmeters, resistance frames, automatic cut-outs, photometers, &c. A number of illustrations are given. Various types of the N. C. S. voltmeters are shown. The "N. C. S." our readers will understand are the initials of the three partners in the company, Messrs. Nalder, Crawley and Soames. We mention this lest the letters should be thought to refer to another manufacturer. In addition to letterpress describing the articles, code-words for nearly all are given. Crawley's patent automatic accumulator switch figures on page 8.

Changes of Address.—Messrs. Bergtheil & Young have removed to more commodious premises at 12, Camomile Street, Bishopsgate Street, E.C.

Mr. Albert C. Hands is on March 31st removing to much larger premises in Garlick Hill, E.C., where he intends to make an extensive show of all kinds of electric light fittings.

Messrs. W. P. Thompson & Co. ask us to state that they have removed to larger premises at 322, High Holborn, W.C.

Campbell Oil Engine.—A catalogue (March, 1896), of this oil engine, as supplied by the Campbell Gas Engine Company, Limited, of Halifax, is before us. The principal features and advantages of the engine are detailed, and a number of large illustrations are given, along with testimonals from users.

"Empress" Lampholder Switch.—This new switch, which is shown in the illustrations below, is being placed upon the market by Munro's Electrical Manufacturing Company, Limited, of Glasgow. The action of the switch is shown in figs. 2 and 3, and consists in "making and breaking" contact by means of one of the

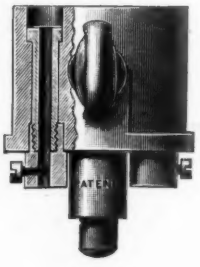


Fig. 1.

Switch Movement in Part Section, showing Ease in Wiring.

plungers used in the ordinary lampholder. By a neat arrangement, also, this plunger is made to turn each time it "makes" or "breaks," and this ensures a thoroughly good rubbing action. This is claimed to be the most easily wired lampholder switch in the market, the wiring being effected in the same way as that of an ordinary lamp-

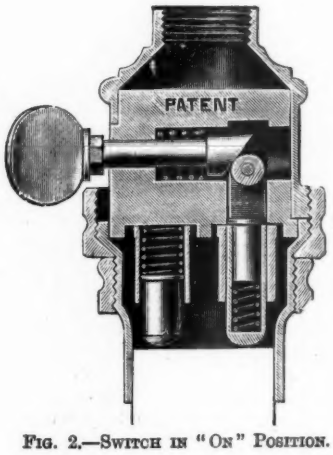


Fig. 2.—Switch in "On" Position.

holder (see fig. 1). It is also stated to be the only lampholder switch in which the working parts are entirely enclosed in the porcelain case, and are not liable to damage when being wired. The wires pass through two separate holes entirely apart from the movement (fig. 1),

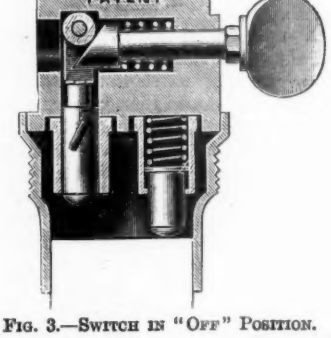


Fig. 3.—Switch in "Off" Position.

and the covering of the wires consequently cannot be damaged, and thus form an electrical fault. It is further claimed to be the only lampholder switch in which half of the contact part is renewed each time the lamp is renewed. It can be used on a light ornamental fitting, where the ordinary lampholder switch might look clumsy.

Large Order for Turbines.—The Lachine Rapids Hydraulic and Land Company, Limited, of Montreal, Canada, have placed an order with Mr. Frederic Nell for 66 54-inch cylinder gate "Victor" turbines, together with all the gearing, shafting, &c., for transmitting the power to electric generators. The power will be transmitted electrically into the city for street railway and lighting purposes. This is believed to be the largest contract for turbines ever placed.

Messrs. Crompton's Works.—According to the *Essex Newsman*, difficulties appear to have arisen at Chelmsford between Messrs. Crompton & Co. and the Town Council, which render it uncertain whether the new works will be erected in Chelmsford or some other town. Negotiations are still being carried on, though it is stated that the company has already inspected a site in another town.

New Edition.—Messrs. Whittaker & Co. will shortly publish Vol. I. of the third edition of "Electric Lighting and Power Distribution," by W. Perren Maycock, M.I.E.E. The work will be in two volumes, and a glance at the advance copy of the syllabus which we have received, reveals the fact that it has been very much enlarged.

Reduction of Capital.—The petition to which we referred last week for the reduction of the capital of the Manchester Edison-Swan Company, Limited and Reduced, from £550,000 to £350,000, came before Vice-Chancellor Hall, Q.C., at Manchester a few days ago. The reduction is to be effected by extinguishing the liability in respect of uncalled capital to the extent of £4 per share. His Honour sanctioned the proposed reduction, and continued the use of the words "and reduced" in the title of the company for one month longer.

Safety Wall Plugs.—Referring to the safety wall plug described in these columns last week, and the claims made for it by the manufacturers, we have now received a letter from Mr. A. P. Lundberg stating that Messrs. Hodges and Todd are mistaken in saying that theirs is the only side contact wall plug, and the only one that can be used in special positions where space is limited. He says that more than four years ago he improved upon a rough pattern of wall socket and plug of the same description, and supplied some dozens to a London firm, who afterwards exhibited some of them at the Crystal Palace Electrical Exhibition, 1892. These fittings did not extend more than one inch from the wall when fixed, and this distance could have been reduced if necessary. Mr. Lundberg states that he has also used the same principle of side entering plugs (both single and double pin) for stage fittings, carpet sockets, lamp standards, brackets, &c., for several years. He further believes they were used by Sir David Salomons about six years ago.

ELECTRIC LIGHTING NOTES.

Aberystwyth.—A local paper says that the Council has voted the payment of £803 19s. to the Bourne & Grant Electricity Supply Company for the arc lamps and pillars.

Asylum Lighting.—The electric light installation at Purdysburn Asylum comprises two Bumsted & Chandler single-crank engines coupled direct to two E.C.C. continuous current dynamos, each capable of giving 90 amperes 100 volts at 500 revolutions per minute. The batteries consist of 56 E.P.S. K 17 cells, in glass boxes, capable of discharging 100 amperes for one hour. The installation consists of about 10 32-C.P., 90 16-C.P., and 150 8-C.P. lamps of the Edison & Swan Company's make. There is also a 3 H.P. motor by Thomas Parker, Limited. The entire plant was supplied and erected by Mr. William H. Drennan, electrical engineer, of Belfast, under the superintendence of Mr. John Bradin.

Birmingham.—A report prepared by a committee of the Medical Institute for 1895 records the installation of the electric light in the library and reading room. This was done without expense to the Institute. So far as can be judged from a three months' trial, it seems likely that the electric light will show a distinct saving as compared with gas.

Bristol.—It appears likely, from what the *Bristol Mercury* says, that the Council will be asked to vote £60,000 for extensions in connection with the electric light undertaking.

Cardiff.—The Council has just rescinded a contract for 30 special lamp pillars for electric lighting, as the contractor does not pay so-called "fair" wages. The tender of Mr. Evans, of Llandaff, now accepted, is for 13s. 6d. per lamp higher than that first chosen.

Chelsea.—The Vestry will not oppose the application of the Chelsea Electricity Supply Company for a provisional order to light the western portion of the parish.

Dewsbury.—At a recent Council meeting minutes were confirmed which showed the consumption of current in February as follows:—Fortnight ended February 8th, 5,669 units; fortnight ended February 22nd, 4,906 units. The electrical engineer has been instructed to lay an extension of the mains in Bradford Road.

Eston.—At the last Council meeting several members expressed their dissatisfaction with the present lighting arrangements. The surveyor stated that plans for electric lighting in the district had been drafted, and estimates will shortly be to hand for lighting the streets with electricity.

Fareham.—The Council has appointed Mr. Blake, jun., manager at the electric light works.

Glasgow.—The minutes of the special sub-committee on proposed extension of electric lighting plant contained a report by Mr. Foulis and Mr. Arnot, stating that a saving of £688 would be effected by transferring the arc lighting from John Street to Waterloo Street, and supplying the lamps from the low tension mains at present used for private lighting. This saving was equal to £6 10s. 4d. per lamp, reducing the cost per lamp per annum to £22 10s. 1d. The committee approved of the report. The minute was approved by the Corporation. The Corporation also adopted the committee's recommendation that, as an experiment, eight of the existing arc lamps at the west end of Sauchiehall Street be, as soon as practicable, replaced by lamps of a new design, and thereafter connected with the mains from the Waterloo Street station.

The Electric Lighting Sub-Committee is asking the students of the School of Art and the School of Design to send in designs for a wrought-iron bracket for continuing the existing lamps, and rendering them suitable for a pendant globe. A small premium is offered.

Hammersmith.—Mr. A. H. Preece was recently called in by the Electric Lighting Committee to report upon the schemes and tenders received for electric lighting. Mr. Preece in his report recommended the alternating current transformer system, stating that Messrs. Siemens Bros.' tender was the lowest, and recommending that revised tenders be invited and submitted for complete station plant, leaving the mains to be dealt with hereafter. This advice was adopted, and the further tenders submitted to Mr. Preece, who reported that it would be more economical to accept Messrs. Ferranti's tender. The committee therefore recommended that the tender of Messrs. Ferranti, Limited, for sections A, B, C, D, and E of the specification, for the sum of £12,302 12s. be accepted. The Vestry on 20th inst. confirmed this decision, and also adopted the report of the same committee appointing Mr. Preece consulting engineer at a remuneration of 2½ per cent. on the accepted tender, and 5 per cent. on all future work for which specifications would have to be prepared.

Holloway.—Among other improvements contemplated at the Parkhurst Theatre, Holloway, is the installation of the electric light.

Hull.—The Electric Lighting Committee has before it a report from the Corporation electrical engineer, Mr. A. S. Barnard, regarding the proposed extensions of electric lighting. Mr. Barnard names a number of streets where he suggests the mains should be extended, and these cover over 14,670 yards.

Japan.—The Yokohama Union Electric Light Company reports a profit of 13,072 yen for the second half of last year, and has declared a dividend at the rate of 10 per cent. per annum.

Lambeth.—On March 18th, a meeting of residents and ratepayers was held at the Effra Hall, Brixton, to propose the advisability of the Vestry undertaking the electric lighting of the parish under the provisional order which they hold. Several of the leading inhabitants of this extensive district spoke, including Mr. W. L. Madgen, who was in favour of the proposition. Resolutions were carried protesting against the action of the Electric Lighting Committee in refusing to receive a deputation of ratepayers, and calling upon the Vestry to lay the full facts before the public.

Llanelly.—Mr. J. C. Howell has made an offer to the Borough Council to supply the chief streets of the town with 24 arc lamps, and keep them lighted at a cost of £500 per annum, and to supply the two market halls, the Athenæum, and the new Town Hall at 4d. per unit under a 10 years' contract.

Llandrindod Wells.—In accordance with an arrangement made a few weeks ago, to which we referred at the time, the District Council last week rescinded the resolution accepting the offers of Messrs. Jevon & Thomas, and accepted the alternative scheme suggested by Mr. Edward Davies. As might have been expected, the matter did not pass without a protest from Messrs. Jevons and Thomas's legal advisers. A special meeting of the Council is to be held shortly, at which Mr. Davies will discuss the subject generally.

Leamington.—The Midland Electric Light and Power Company has asked to be allowed to make an offer to the Town Council for lighting the public thoroughfares by means of arc lamps. The letter stands referred to a committee.

Liverpool.—"Electrician," writing to the *Liverpool Post*, complains that the Corporation have given out contracts for the electric wiring of St. George's Hall and the municipal offices to the Liverpool Electric Supply Company, without inviting tenders for the work from ratepaying electrical engineers in the neighbourhood.

In the Commons, on Monday, the Liverpool Electric Supply (Transfer) Bill was read a second time.

London, W.C.—The *Morning*, in a strange note regarding the bad lighting of a certain portion of Piccadilly, says the cause of the gloom is the "total abstinence of gin-shops and advertising tailors," and, further on, dubs these two classes of the community "public philanthropists." The gas lamps are suggestive of the last century, he remarks, and electricity has not yet reached this patrician highway. We question the total abstinence of gin-shops, and the length of a bill convinces many a man that few tailors are philanthropists. But what has all this to do with the lighting of Piccadilly? Surely the *Morning* is a little mixed!

London.—Amongst the items which appear in the Civil Service Estimates this Session for the first time is a charge for sundry improvements in Hyde Park, including the electric lighting not only of the band-stand, but also of the footpath between Marble Arch and Albert Gate.

Manchester.—The Council has advanced the salaries of four officials of the Electric Light Department, without any opposition—the chief engineer from £500 to £600 per annum, and three electricians to £200 per annum each from £3 3s. and £2 16s. 6d. per week.

Morley.—The Corporation requires the services of a competent man to take entire charge of the electric light installation at the Town Hall. Applications to the Town Clerk by 30th inst.

New Swindon.—Mr. J. G. W. Aldridge (electrical engineer) is to report to the District Council *re* electric lighting.

Paisley.—We learn that the Council, sitting in committee, has resolved to acquire the necessary plant for providing the electric light within a radius of half a mile from the old prison buildings in the centre of the town, where the station will be erected.

It has been decided to proceed at once with the operations for the lighting of the Clark Town Hall and Free Library and Museum.

Peterborough.—A correspondent of the *Peterborough Standard* raises several objections to the proposed electric lighting scheme. In the same paper is printed a copy of a statement lately prepared by the Council's engineer, showing the estimated annual cost of working and the income. We take the following details from his statement:—

Annual cost of working...	£1,348
Total annual expenditure (including interest and depreciation)	3,128 odd.
Annual cost of street lighting	721 „
Private incandescent lighting	2,407 „

Sandycroft.—At a Parish Council meeting some days ago the lighting question came up. Mr. Wm. Kelly said he had already asked that the Mechanics' Institute be supplied with the electric light by the Sandycroft Engine Works Company, but was afraid that the generating plant they were now fitting up would not be equal to the supply of the village. He thought, therefore, the better way would be to have a generating station in the village.

St. Pancras, N.W.—The Vestry finding it necessary to provide spare plant for the King's Road station at a cost of £6,300, tenders are to be invited for the work.

South Shields.—We have received a copy of a very good pamphlet on "The Electric Light," prepared by Mr. J. A. Jeckell, the Corporation electrical engineer, which is being distributed to the shopkeepers and householders of the borough, setting forth the many advantages of the electric light.

Strand, W.C.—A House of Commons Select Committee last week passed a Bill confirming a provisional order granted by the Board of Trade to the Charing Cross and Strand Electricity Supply Corporation, Limited, authorising them to light the area of the Strand District Board of Works. The Bill has been opposed by the Metropolitan Electric Supply Company, Limited, who already supply the Strand district, but it was put forward in evidence that, whilst the Metropolitan Electric Company use the high tension current, the Charing Cross Company would supply the direct low tension current, which would be a great advantage to all who require electricity for motive power. It was stated on behalf of the promoters that if the Charing Cross Company obtained the powers sought it would be to the advantage of the users of the electric light in the district, as it would introduce healthy competition. A petition in favour of the Bill had been signed by the proprietors of practically all the theatres and all the newspapers in the district, as well as by many of the principal ratepayers. This Bill has now received the sanction of both Houses. The Charing Cross Company is sending out a printed circular recording the decision of the Select Committee.

Southampton.—For Wednesday's Council Meeting the Mayor had a resolution on the agenda moving the appointment of an Electric Lighting Committee to settle all questions connected with electric lighting matters. The Council last week resolved upon the recommendation of the Works Committee to purchase the Southampton Electric Light and Power Company's undertaking for the sum of £21,000, and to take over the existing contracts for stores, coal, &c. Application is being made to the Local Government Board for a loan of £50,000 to cover these sums, and to allow for necessary extensions.

Sunderland.—A Local Government Board inquiry was held on 20th inst. as to the application of the Corporation to borrow £16,000 for the purposes of further developing the electric light.

Train Lighting.—The Great North of Scotland Railway Company have now fitted up five first and third class carriages and two composites with the Stone & Gill system of electric lighting. The five run on the Dyce suburban service, and the two are available for the main line. The Dyce carriages have been running for some weeks with perfect satisfaction, and the others have just been put on.

Wakefield.—The Sewage and Electric Lighting Committees having considered the plans for sewage disposal and electric lighting works, the City Council has resolved "that it be a recommendation for the consideration of Mr. Hammond, electrical engineer, that the chimney be removed some distance from the buildings." The Committees have been instructed to obtain tenders for carrying out the works of sewage disposal, electric lighting, and refuse destructor.

Wolverhampton.—During a recent visit to Wolverhampton, we were much impressed with the excellence of the street lighting. The central district of the town which is mostly lighted by arc lamps, can certainly vie with the best lighted towns in the country. We understand from Mr. Harman Lewis that most satisfactory progress has been made since the opening of the works. The plant is being worked to its fullest capacity, and scarcely another customer can be added to the mains. Up to January of this year 172,207 units had been sold, and the cost of production comes out exceptionally low, the works' cost being 1·87, and the total cost being 2·89d. This figure includes trimming and maintenance of street arcs, of which there are 42, and if deducted would probably reduce the cost by ¼d. per unit. A recent test of the whole system showed the efficiency of the plant, including a battery of accumulators, to be 70 per cent. Mr. Harman Lewis is to be congratulated on the excellent results he has obtained.

Worcester.—The Market Hall is now lighted by 10 arc lamps, the work having been carried out by Mr. Santonna.

A memorial from 56 owners and occupiers of property in St. John's asking for electric arc lamps to be extended to the west side of the river, has been referred to a sub-committee for consideration and to report.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Cape Town Electric Tramways.—We learn by the last mail from South Africa that work is rapidly approaching completion on the construction of the electric tramways in Cape Town. The power station comprises engine and boiler rooms each 84 feet × 39 feet, and coal store, 84 feet × 41 feet. The work of erecting the boilers, of which there are three of 300 H.P., of the Heine type, is now in hand. The laying of the rails, and the erection of the overhead conductor, is also well in hand.

Dublin Tramways.—The Dublin Southern District Tramways Bill came before the Examiners in the House of Commons, on 19th inst., for proof of compliance with the preliminary Standing Orders. There was no opposition at this stage, but after hearing the formal proofs, the Examiners decided that the Standing Orders had not been complied with. The matter will accordingly have to go before the Standing Orders Committee, who will decide whether or not the orders may be dispensed with.

Dublin Tramways Opposition.—The Rathmines Commissioners intend to oppose the memorials for an order of the tramways, shown in the plans of the Dublin United Tramways Company and the Rathmines, Dundrum, and Blackrock Tramways Company. The Drumcondra Commissioners have heartily approved the Dublin United Company's scheme, and seem very favourably disposed towards electricity.

Electric Traction in Russia.—A concession is reported to have been secured by a German company for the establishment and operation of a system of electric tramways in the town of Orel.

Electric Power at Barberton.—Mr. W. B. Esson, writing to yesterday's *Financial News*, says:—"I have read with interest the leader on 'Barberton Mining' in your issue of the 24th inst.; but with regret note the results of the attempts to crush by electric power at the Moodie's Fortuna. To the uninitiated your remarks, and also the report of the Moodie's Fortuna board, would amount to a condemnation of electric transmission of power as applied to gold mining. It is my purpose to show, however, that, properly engineered, power transmitted electrically can be made as reliable as power obtained by any other means, steam included, and that the uncertainty of the electric power at the mine in question, due to whatever cause, cannot be held as condemning in any sense the use of electric power generally. By a curious fate the Sheba Mine, which might be called next door to Moodie's, has also an electric plant, and has for over 12 months depended solely and absolutely for its crushing of power transmitted electrically. By a still more curious fate, while Moodie's Fortuna records a failure, the Sheba has recently recorded crushings which have been unprecedented, and which, you will allow, bears ample evidence of what electric power can do. In the reports of Moodie's Fortuna it is stated that doubts as to the practicability of electric power were entertained from the first. When Messrs. Johnson and Phillips took the order for the power plant at Sheba there were no doubts whatever in the minds of the contractors or their engineers as regarded the ultimate success of the scheme. Applied to the exigencies of gold mining, there were, of course, certain details which required to be modified as the work proceeded; but respecting the final results which would be brought about there was no question. As the system at Sheba is quite different from the system at Moodie's, it is possible that to this is to be attributed in no small measure the difference in the results. The use of two alternating currents for the transmission at Sheba enables the whole plant to be much more easily managed than would be possible were a direct current used, as I understand is the case at the neighbouring mine. The results at Sheba speak for themselves. The

electric power is transmitted through cables five miles long, and the mill works night and day, never stopping save for an occasional examination of the machinery at the generating or receiving end of the lines. For the four months ended February 29th the mill worked night and day, with stoppages aggregating in that time only one day and a half in all. This amount of stoppage was made up of a quarter of an hour here and twenty minutes there to take up a belt, adjust a rope, examine a bearing, or to give to the plant any of the little attentions always required from time to time by running machinery. The record, as it stands, forms an undeniable tribute to the success of power transmission by electricity, and it will be obvious that what has been done at Sheba can be done elsewhere, if the problem be tackled in the right manner."

Portsmouth and Electric Tramways.—The Town Council has appointed a committee to open negotiations with the Tramway Company for the purchase of their system of tramways and leasing it to the company, and supplying them with electric energy for their cars upon terms to be mutually arranged. Portions of the Portsmouth tramway system which have been recently relaid have been fitted with copper bonds, with a view to the utilisation of electricity as the propelling agent.

Proposed Electric Tramways.—The inhabitants of Holywood and district have approved the construction of an electric tramway from Belmont to Holywood, and have agreed to further the project as far as possible. Arrangements are in hand for getting money together to meet the preliminary expenses.

In view of the anticipated increase of passenger traffic, due to the Irish tourist development movement, it is stated that a line of tramway, to be worked electrically, is being projected from Larne to Cushendall, and probably on to Portrush. A syndicate has been formed to promote this project.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

CABLES.

	Down.	Repaired.
Brest-St. Pierre (1869, Anglo)	April 6th, 1895 ...	...
" " (P.Q.) ...	June 24th, 1895 ...	...
Brest-Penzance (P.Q.) ...	... ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Aden-Zanzibar	Mar. 16th, 1896 ...	March 22nd, 1896

LANDLINES.

Communication with Mata-galpa Provinces of Leon and Chinandega ...	Feb. 26th, 1895 ...	...
Trans-Continental line beyond Mazol (Mashona-land) Telegrams for Tohikwawa and Blantyre cannot be accepted.	March 12th, 1896 ...	...
Saigon-Bangkok	Mar. 20th, 1896 ...	March 20th, 1896

March 20th, 1896.—Eastern Company announce a delay of 48 hours on ordinary telegrams to and from South Africa.

March 24th, 1896.—Berne notifies there is no more delay on South African telegrams.

The Telephone Service.—In the House of Commons, on Friday last, Mr. Henniker Heaton asked what percentage of the receipts of telephone companies is payable to the State; and what amount was actually received by the Post Office from the telephone companies during each of the past five financial years. Mr. Hanbury, in reply, stated that the royalty is 10 per cent., and the amounts received during the past five financial years were:—1890-91, £44,007; 1891-92, £50,403; 1892-93, £57,620; 1893-94, £65,443; 1894-95, £72,693.

Telegraphs in West Perthshire.—Sir Donald Currie has been informed by the General Post Office that the Postmaster-General is unable to carry out his recommendation for a telegraph extension to Gartmore, Perthshire.

Unsatisfactory Cables to South Africa.—We have still again to remark on the delay in telegrams, and consequent public inconvenience, arising from the spasmodic way in which telegraph communication between England and South Africa is kept up within the last few months (during which events of the greatest possible importance to the relations between England, the Transvaal Republic, and Germany, have occurred). We have frequently had to call attention to the hopeless collapse of the present inefficient cable system, a system which is very largely subsidised to maintain communication between England and South Africa, and which, even with the intermittent and irregular service which prevails, manages to pay very handsome dividends to the shareholders. On the present occasion the Aden-Zanzibar cable (our old friend once more!) broke down on the 16th, and was not repaired until the 22nd—a week later. During this time telegrams from South Africa, the Seychelles, and Mauritius, suffered a delay of several days in some cases. Last week Sir Charles Dilke very properly called the attention of Parliament to the need of a reliable telegraph service to the Cape, and unquestionably recent experience has proved that the present lines are really a source of weakness, as they, to a great extent, bar the way to the establishment of a cable system which would fulfil the reasonable expectations of the public and of the Government.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—June 1st. The municipal authorities of Prague are inviting tenders for the erection of and equipment of a municipal electricity generating station in the town for electric lighting, power, and tramway traction purposes. Tenders are to be directed to the Stadrath der Haupt, Stadt Prague, Prague, Austria, from whom full particulars may be obtained.

Bedford.—April 4th. Tenders are being invited by the Electric Light Committee for the supply and erection of one 240 B.H.P. double-acting compound enclosed engine, and one 150-unit alternator, with stationary armature. Specifications, &c., may be obtained at the offices of Mr. T. S. Porter, Clerk to the Urban Sanitary Authority, Town Hall, Bedford.

Bradford.—April 8th. The Corporation is inviting tenders for erection of a building required for the new electricity station at the junction of Valley Road and Lionel Street in the borough. Details on application to Mr. Thomas Barker, A.M.I.C.E., architect, at his offices, 5, Bond Street, Bradford.

County Antrim.—May 1st. The Commissioners for the control of Lunatic Asylums invite tenders for the supply and erection of an electrical installation at County Antrim Lunatic Asylum.

Derby.—April 13th. The Corporation wants tenders for the supply and laying of low tension cables and junction boxes in the borough. For further details see our "Official Notices."

Edinburgh.—March 28th. Tenders have to be in to-morrow for the wiring of the City Chambers, for the Corporation.

Eston.—May 1st. The District Council invites schemes for lighting the district by electricity, such schemes to embrace (*a*) plan and estimated cost; (*b*) annual working cost and maintenance. Particulars from the District Surveyor, Grangetown, Yorkshire.

France.—March 31st. Tenders are invited for the supply of a multiple telephone switchboard. Tenders to be addressed to the Direction Générale des Postes et des Telegraphes, Rue de Grenelle 103, Paris.

France.—April 9th. The municipal authorities of Paris are inviting tenders for the supply of eight candelabras required in connection with the electric lighting of the Quais de Jemmapes et Valmy. Tenders to be sent to the Hotel de Ville, Paris.

Harrogate.—April 7th. The proprietors of the Prince of Wales Hotel want tenders for an electric light installation (about 400 lights) including generating plant, also telephone and bell installations. Further details will be found in our "Official Notices."

Lima.—June 1st. The Municipal Council is inviting tenders for the establishment and working of the electric lighting in the squares and streets of the city, with power to work the private supply under a 20 years' contract. Particulars to be obtained at the Peruvian Legation, 13, Comeragh Road, West Kensington, W.

Peru.—June 1st. The Municipal Authorities of Lima, Peru, are inviting tenders for the concession for the electric lighting of the city. Tenders are to be directed to La Legation de Perou, 8, Avenue Hoche, Paris, from whom particulars may be obtained.

Shoreditch.—April 14th. The Vestry invites tenders for engines, dynamos, pumps, mains, transformers, accumulators, &c., for the generating station. Specifications, &c., from Messrs. Kincaid, Waller, and Manville, 29, Great George Street, Westminster.

Wallasey.—April 6th. The District Council is prepared to receive tenders for the undermentioned works, viz.:—*a*, Steam alternators, switchboard, and accessories; *b*, High and low tension concentric cables; *c*, Transformers. Particulars may be obtained on application to the Engineer, Mr. J. H. Crowther, at the Gas and Water Works, Great Float, near Birkenhead.

CLOSED.

Brighton.—The Council has accepted the tender of Messrs. Willans & Robinson, to supply and erect a 750 I.H.P. steam engine and Crompton dynamo, at the Corporation Electricity Generating Station, for the sum of £4,655.

Hammersmith.—As will be seen from our "Electric Lighting Notes," Messrs. Ferranti's tender for the electric lighting plant at £12,302 has been accepted.

Huddersfield.—The Borough Council has accepted the following tenders:—Messrs. Babcock & Wilcox, Limited, for two tubular boilers; Messrs. Meldrum Bros., for new blast furnace; and Messrs. R. Stevenson & Co., Newcastle-on-Tyne, for condensing plant.

Durban, Natal.—Tenders, as below, have been received for the electric lighting plant. Borough engineer: J. Fletcher; consulting engineer: W. H. Radford, C.E., Nottingham Corporation; agents: Webster Steel & Co., East India Avenue, London, E.C.

J. G. Statter & Co., 68, Victoria Street, London, S.W. ..	£17,904 0 0
Wigston Electrical and Engineering Company, Ltd., London	17,360 0 0
British Thomson-Houston, Limited, Westminster, S.W. ..	20,057 3 0
Goddard, Massey & Warner, Nottingham	23,926 0 0
The Brush Electrical Engineering Company, London, E.C.	16,365 0 0
Siemens Brothers & Co., Limited, Woolwich	16,350 0 0
Crompton & Co.. Limited, London, E.C.	15,001 16 0
Electric Construction Company, Limited, Wolverhampton (Accepted, subject to modifications)	15,007 0 0
Tendered for cables only:	
The Telegraph Manufacturing Company, Limited, Helsby ..	6,114 0 0
The India-Rubber, Gutta-Percha, and Telegraph Works, Limited, 106, Cannon Street, London, E.C.	5,442 14 0

CITY NOTES.

City of Bath Electric Lighting Company.

The annual report shows the most satisfactory results ever obtained by this Company in any year's working. The gross profit amounted to £1,570, and after payment of bank charges and mortgage and debenture interest, there remains a net profit of £1,131. Although this sum would have provided the shareholders with a 4 per cent. dividend, the directors very wisely, in view of impending changes, resolved to put it to a reserve fund. Our columns bear evidence that the undertaking has, from its inception, been heartily disliked by the local authority, and hence it is not surprising that the Company, in its recent application for a provisional order should have met with the opposition of the local authority. Matters have been still further complicated by the local authority applying for a provisional order. The result of the two applications was that a meeting was held at the Board of Trade, at which Sir Courtney Boyle proposed the appointment by the Board of Trade of an independent valuer to report to the Board on the value of the Company's property. Prof. Kennedy has since been appointed valuer, and no doubt his report will help to clear up matters a little.

	1893.	1894.	1895.
Total capital invested ...	£38,774	£41,087	£42,871
Number of units sold	238,162	209,077	266,565
Number of lamps connected ...	7,070	8,327	11,207
Arc lamps	84	84	84
Revenue from sale of current...	£4,621	£4,594	£5,328
Net revenue	—	—	£1,131
Average price obtained per unit	—	—	4·8d.

Cost of production.	£	s.	d.		Per unit.
Coal	1,549	0	0		1·40d.
Oil, waste, water, and engine room stores	367	0	0		·33d.
Salaries and wages at generating station	984	0	0		·90d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	387	0	0	Works' cost 2 98d.	·35d.
Rates and taxes	125	0	0		·11d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,020	0	0		·91d.
Depreciation of buildings and plant account	—				—
Renewal fund account	—				—
Total	£4,432	0	0		4·0d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	5,328	0	0	—
Meter and transformer rents	132	0	0	4·8d.
Sale of lamps	776	0	0	—
Total	£6,236	0	0	4·8d.

Total cost per unit (exclusive of depreciation and renewal accounts), 4·0d.; works' cost, 2·98d.

The Scarborough Electric Supply Company.

This company continues to make fair progress. The gross revenue amounts to £3,613 19s. 5d. Deducting the expenses from this, there remains a balance of £937 9s. 8½d., which is nearly double the profit that was made in 1894. There has been a considerable accession of customers during the year, and the number of lamps has increased by 2,285. It is satisfactory to find that the company has reached the dividend paying, 2½ per cent. being declared. To meet the increased demand, an additional boiler and two additional sets of engines, dynamo and condenser, one set of 150 horse-power, and one of 100 horse-power have been erected.

There has been a considerable increase in the output, and the cost of production has been slightly reduced.

	1893.	1894.	1895.
Total capital invested	—	£25,987	£30,906
Number of units sold	—	86,594	135,177
Number of lamps connected ...	—	—	12,788
Revenue from sale of current...	—	£2,186	£3,368
Net revenue	—	£505	£937
Average price obtained per unit	—	6·05d.	6·0d.

Cost of production.	£	s.	d.		Per unit.
Coal	937	0	0		1·66d.
Oil, waste, water and engine room stores	67	0	0		·12d.
Salaries and wages at generating station	596	0	0		1·05d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	355	0	0	Works' cost 3·46d.	·63d.
Rates and taxes	73	0	0		·13d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	281	0	0		·50d.
Depreciation of buildings and plant account	—				—
Renewal fund account	—				—
Total	£2,309	0	0		4·09d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	3,368	0	0	—
Meter rents	99	0	0	6·0d.
Sundries	4	0	0	—
Total	£3,471	0	0	6·0d.

Total cost per unit (exclusive of depreciation and renewal accounts), 4·09d.; works' cost, 3·46d.

The Brighton Figures.

Two serious errors occurred in our analysis of the Brighton accounts last week. The average price obtained per unit in the year 1894 should have been 6·12d. instead of 4·5d. Again, in the 1895 figures we made the average price obtained 4·85d., against the actual figure of 4·71d.

Scarborough Electric Supply Company, Limited.

On Thursday, last week, the fourth ordinary general annual meeting of this company was held at the Grand Hotel, Scarborough. Mr. J. W. Woodall, J.P., occupied the chair, in the absence, through illness, of the chairman of the company, Mr. George Alderson Smith, J.P.

The Chairman, in moving the adoption of the report, said he would wish them to remember that that statement represented the first whole year's working, because during 1894 they had hardly settled down to the work and conditions of supply. The policy pursued by the members of the board had been, and would be in the future, to give as good a supply as possible to the consumers, whilst attempting to carry out such economy as would eventually conduce to the proper working of the concern. Owing to the expense incurred by the great amount of current that was required at a late period of the autumn, their receipts per lamp did not show a very large average. But, on the other hand, the cost of production per unit would compare very favourably indeed with that of other companies which were far better situated for a continual demand. A moderate increase in the winter supply and a further demand would show better results, and there was every reason to hope for such a demand in the future. The result of the working for the year, according to the balance-sheet, would allow a dividend to be paid at the rate of 2½ per cent. on the paid-up capital, after writing off sundry expenses connected with the formation of the company. The result of the working, after bringing forward £418 12s. 3d. from the revenue account of the previous year, showed a balance to the credit of the revenue to the amount of £937 9s. 8½d., which made a total of £1,356 1s. 11½d. available for distribution. Of this sum, they were reminded by the directors that £304 should be written off from the preliminary expenses, which would leave a sum of £350. There was another item which would also have to be reduced regularly, and that was the provisional order of £525. That would have to be written down, and would have to be provided for in the reserve fund. Then they proposed to pay out of the £1,356, less the £304, £772 less income-tax on the share, and to carry forward an amount of a little more than £278. This would, he thought, be all that they could do that year. They were bound to look forward and provide a year's income for the

company for the future. In conclusion, Mr. Woodall said he begged to move the adoption of the report and balance-sheet, and that a dividend of 2½ per cent. be declared upon the amount standing to the credit of the shareholders.

Mr. A. A. Campbell Swinton seconded the motion. He said that it appeared to him that the progress of the company, though slow, was very satisfactory. Of course, many companies could go ahead very much quicker than that one was going, which was due to the fact that the people in Scarborough consumed a very small amount of electricity per lamp. Coupled with that they supplied current at a very low rate, much lower, in fact, than was the case in some places, and they only get a little under 5s. 6d. per lamp. He would point out that as the total number of lamps increased, and the consumption increased, the expenses would not increase in like proportion. In the year before last and last year they made a profit of £418, and this year they had made more than double that profit. That improvement would probably go on. £5,300 was the amount they had spent on new machinery and extra mains during the year to meet the increased number of lamps, which amounted to 2,285, which had been connected during the year. Referring to the saving that might accrue from adopting the electric light, he read the following letter which had been received at the company's offices from Messrs. John Rowntree & Sons, 20 and 21, Westborough:—"Dear Sir,—We send you, as requested, the following particulars of the cost of gas and electric light at 20 and 21, Westborough: Cost of gas—1891, £38 7s. 11d.; 1892, £34 5s. 2d.; 1893, £36 6s. 9d. 1895, £8 12s. 6d. gas and £20 15s. 6d. electric light—£29 8s. We have 55 electric lights, varying from 8 to 32 candle-power. Our premises are quite as well lighted now as previously with gas, though we have not increased the brilliancy; we have also added a gas stove since putting in the electric light. The figures include the gas used for a small gas engine, gas stove, and two gas rings. Practically, we use no gas for illuminating. This shows an average saving of over £5 10s. per year. We attribute it very largely to the care taken in not leaving the lights on when not required. Mr. Alderson Smith is at liberty to make use of these figures if they are of any service to him.—Yours, &c. (signed) G. Rowntree. To Mr. G. S. Peck, resident engineer, Scarborough Electric Supply, 102, Westborough."

The report and balance-sheet were then adopted.

The Tramways Electrical Traction Company, Limited.

The report of the directors to be presented to the shareholders at the ordinary general meeting to be held at the company's offices on Monday, March 30th, 1896, at four o'clock in the afternoon, states that the shareholders are aware that the primary object of this company was to assist the Rouen Tramways Company to electrically equip its system, and to attain this end the board entered into contracts with the French Thomson-Houston Company and others early last year. The necessary works were immediately commenced, and sufficient progress was made to allow of some of the sections being worked by electricity at the beginning of February last. Soon after the initial electrical opening the directors entered into negotiations with the French Thomson-Houston Company for the sale of their interest in the Rouen Tramways Company, with the result that an agreement was come to on the terms of the French Thomson-Houston Company taking over all the liabilities of the company, repaying the cash advances made on account of the Rouen Tramways Company, with interest at 6 per cent., and acquiring for £100,000 the 7,094 ordinary and 48 Jouissance shares in the Rouen Company owned by the company, and these sums will be paid over in cash on April 10th next. The net result of the sale is, that whilst the capital (viz., 15,000 preference shares, £5 paid, and 15,000 ordinary shares of £1 10s. each, fully paid, together £97,500) remains intact, there is a balance at credit of profit and loss account of £81,214 14s. 9d., which it is proposed to appropriate as follows:—

	£	s.	d.
Interest at 6 per cent. per annum on 15,000 preference shares, on amounts paid up from time to time, being 5s. 6d. per share	4,125	0	0
Dividend of £5 per share on 15,000 ordinary shares of £1 10s. each (fully paid) ...	75,000	0	0
Balance to be carried forward to new account	2,089	14	9
	£81,214	14	9

The interest and dividend warrants (less income tax) will be payable on April 15th. The directors congratulate the shareholders upon the satisfactory results thus attained. They propose in due course to take the necessary steps to wind up the company, with the view of returning the paid-up capital on the preference and ordinary shares, viz., £5 per share on the preference shares and £1 10s. per share on ordinary shares.

County of London Brush Provincial Electric Lighting Company, Limited.

The report and statement of accounts of this company have just been issued. The capital expended during the year on the London stations amounted to £92,151, and the investments in shares and debentures, and sums advanced to associated companies, amounted to £73,396, the total being £165,547. This expenditure has been met by instalments falling due on ordinary shares, and by the issue of 10,000 6 per cent. preference shares at par. The balance to credit of revenue account for the past year, after payment of proportion of rents, rates, taxes, &c., amounts to £2,714 7s. 9d., to which must be added £332 5s. 10d. brought forward from 1894 account, making a total of £3,046 13s. 7d. Out of this sum an interim dividend for the half-year ending June 30th, 1895, at the rate of 6 per cent. per annum on the preference shares, was paid on July 15th last, and a further dividend at the same rate is to be paid for the half-year ending 1895; £1,208 being carried forward. The report shows that satisfactory progress is being made with the new stations of the company.

Altrincham Electric Supply Company, Limited.

The second annual meeting of this company was held on Monday at the offices in Manchester, Mr. F. B. Ross, chairman of the company, presiding. The report of the directors recorded a year of satisfactory progress, the company having already secured orders for the equivalent of upwards of 10,000 8-C.P. lamps, a number considerably in excess of their anticipations. The report added that it was satisfactory to note that the loss on the first year's running had been much smaller than was usually the case in similarly new undertakings, in spite of the fact that the directors had considered it desirable to give a continuous day and night service from early on in the year, to meet the views of many of their customers. Although this continuous service had entailed a very considerable extra expense on the year's working, it had resulted in such a considerable increase in the number of customers, that the undertaking might now be considered to have reached a paying basis.

The Chairman, in moving the adoption of the report, said it was with great pleasure he announced that the plant of the company was fully employed; in fact, for several months the company had been compelled to have the whole of the machinery running at the same time during the hours of heavy load. Fortunately, there had been no mishaps, and, in spite of the severe test to which the generating station had been put, they had been able to keep up a continuous and satisfactory supply of light. The directors had considered it desirable to order a new and larger unit of plant capable of supplying current for over 4,000 8-C.P. lamps, thus doubling the capacity of the station. It was expected that this plant would be ready for use by the beginning of August. The number of consumers continued to increase satisfactorily. At the present time, 118 consumers, with an equivalent of 9,532 8-C.P. lamps, were actually connected to the mains, while 21 consumers, with an equivalent of 1,268 8-C.P. lamps, were in course of preparation for connection, making a total of 139 consumers with an equivalent of 10,800 8-C.P. lamps. The directors had considered it desirable to extend the area of the company's operations, and had accordingly applied for a provisional order embracing the urban district of Ashton-on-Mersey, and that portion of the rural district of Bucklow, which included Timperley. This order would probably be granted in July, in which case the company would be in a position to supply light to the residents in September. No doubt this increased area would considerably increase the earning power of the company. The first year's working of the company had resulted in a small loss, but when it was remembered that at the commencement of the year the operations of the company started with practically no consumers connected, and that they had come on by degrees throughout the year, the number of lamps even at the end of the financial year being not nearly so great as at present, it would be seen that this result was very satisfactory. At the present time the income of the company more than paid the expenses, so that the directors confidently anticipate, should nothing unforeseen occur, that at the end of this year's working not only would this loss be wiped off, but a profit would have been made.

Mr. W. P. J. Fawcus seconded the adoption of the report, which was carried.

Sheffield Electric Light Company, Limited.

The fifth ordinary general meeting of this company was held in the Cutlers' Hall, Sheffield, on Monday last. Alderman Franklin, chairman of the board of directors, presided.

The Chairman, in moving the adoption of the report and accounts, said the all important item for the proprietors of the company was the net profit, and the report showed that for the year ending December last there was a net profit of £3,391 9s. 4½d., as compared with £1,943 3s. 10½d. in 1894, and £562 15s. 3½d. 1893. They had before them that day the record of three complete years, and the history of the revenue during that time was one of steady progress—an increase from 1893 to 1894 of £1,400, an increase from 1894 to 1895 of about another £1,400. The history of the undertaking was of comparatively recent growth, but whichever way it was looked at, he thought the shareholders would be agreed that it showed steady progress, and that the anticipations which had been indulged in from time to time had been more than justified. In 1892 there were 7,734 lamps wired, in 1893 they increased to 8,419, in 1894 to 15,672, and in 1895 to 25,552. The return in respect to those lamps for units sold was also equally satisfactory. In 1892 the units sold were 91,524, in 1893 131,752, in 1894 192,220, and in 1895 302,965. It would be seen, therefore, that on which-ever factor they worked their calculation, the result was the same—one of steady, satisfactory progress. The number of customers during the year had increased from 170 to 219, and what was perhaps a still more satisfactory feature, they found new customers were still coming, and that no customers who had had the light were abandoning it. During the year the attention of the directors had been called to the cost of production, because it was manifest that as the "load" increased, the cost of production ought to decrease. A considerable amount of attention had, therefore, been given to that subject, with very satisfactory results. In 1893 the total cost of production and distribution was equal to 5·14d. per unit, in 1894 to 3·80d. per unit, and in 1895 it was reduced again to 3·55d. per unit. So on the "load" of last year they had been able to turn out the electricity at ¼d. less per unit so far as the cost price of the article was concerned. There was still

a large sum being expended every year on capital account. During last year it amounted to £16,426, and the total expenditure on capital account was £68,614. If they compared that with the capital invested on similar undertakings throughout the country, they found that that company was not over-capitalised, and the shareholders would no doubt feel the benefit of that in future years. There was a constant outlay being made by the company in extensions—in spreading the network of mains in order to meet the requirements of their customers. At the present time there were 25 miles of pipes laid under Sheffield streets, and in those pipes there were 45 miles of cables, representing something like 8½ miles of street frontage. If to the balance from last year of £531 17s., they added the profit for the year, they had a total sum of £3,923 6s. 4½d., which represented the sum available for distribution. Obviously the first charge upon that was the interest on debentures, which this year amounted to £1,119 19s. 10d.. Then they had written off, as proportion of formation expenses, £220 16s. 11d., and had transferred to the depreciation fund the sum of £750. Those items absorbed £2,090 16s. 9d., and there was therefore a balance of £1,832 9s. 7½d., from which the directors recommended the payment of a dividend at the rate of 5 per cent. per annum. With reference to the transfer to the depreciation fund, it must be always borne in mind that so far as electric light machinery was concerned, there was no depreciation in the ordinary sense of the word. The machinery and plant had to be as good every day as on the day they were bought, otherwise they would not be able to do the work required from them. They were, therefore, renewed and maintained out of revenue, and in addition to that, the directors had set the substantial sum of £2,000 on one side as a depreciation fund. Remembering the fact that it was only three years since the company got their provisional order, he thought the record of work would be considered fairly satisfactory. The growth in the revenue from electric light was also satisfactory. In 1893 the revenue was £3,555, in 1894 £4,849, and in 1895 £6,935. Upon the question of the increase in the capital expenditure, it would be seen from the report that the directors had found it advisable to issue more shares. There was a margin of authorised capital of 5,375 shares, and the directors had decided to offer to the existing shareholders, at the very moderate premium of 10s. per share, 3,375 of the new issue. They had acquired from the gas company a piece of land in Commercial Street, close to the telephone offices, upon which, sooner or later, they hoped to erect a structure of their own. The shareholders of that company had got a very satisfactory investment. The aim of the directors was to supply not only the best and brightest, but the cheapest of all illuminants, and they believed that if anything could be done to utilise the day "load" they would be able to supply the electric light at lower prices than were obtaining to-day, although the rates in Sheffield were by no means the highest. Looking a little beyond the figures he had mentioned, he had been very much struck with even the work of this year. They all knew how remarkably dry and clear the winter had been. There had been no fogs worth mentioning, and Sheffield had looked abnormally bright. Yet the output, compared with the corresponding period last year, showed an increase of 33 per cent. Whichever way they looked at the undertaking, he thought they would find that the anticipations of the directors had been justified, and that they had not been over-sanguine, and though a dividend of 5 per cent. was not a large one, yet, considering the enormous difficulties with which the directors had had to contend, he could not help thinking—at all events he sincerely hoped—the shareholders would regard the result as satisfactory.

The report was adopted.

Direct Spanish Telegraph Company, Limited.

Mr. Edmund Etlinger presided at an ordinary general meeting of this company, held at the offices of the company on Tuesday last. In his opening remarks, the chairman expressed great regret at the serious illness of Sir John Pender, and trusted that he would soon be restored to health. The year 1895 had not been on the whole an unfavourable one. They had earned sufficient money, after deducting not only the ordinary expenses for working the traffic, but some rather extraordinary expenses, to enable them to recommend a dividend of 10 per cent. for the whole year on the preference shares, and a dividend of 4 per cent. for the whole year on the ordinary shares. They would remember that half of this had been already paid as interim dividends. The receipts had exceeded by £4,571 the receipts for the year 1894, but it was only right to say that 1894 was one of the poorest for many years. As a matter of fact the 1895 receipts only exceeded the average by £1,400, and this increase was not entirely due to ordinary trade. As they were aware, there had been throughout this period a serious insurrection in Cuba, which had brought a vast deal of traffic over their wires. The ordinary expenses for working the traffic had been £238 more, but there had been exceptional expenses amounting to £1,953, of which, however, £1,660 was attributable to the damage done to the Bilbao cable in 1894. In November of that year a steamer fouled their cable outside Bilbao. They brought an action against the owner of the vessel, but they failed. Still, one good thing had arisen out of the action, so far as the future of all submarine telegraph companies was concerned. It came out during the trial that the ship which fouled their cable got its anchor entangled with two cables, one of them probably an abandoned cable of the Spanish Government. Both cables were dragged up to the surface, but the lighter of the two got disengaged from the anchor and disappeared, while with the other, which the company claimed as theirs, nothing could be done, so it was severed. The important part of the judgment was in the following passage:—"If we were satisfied that the cable belonging to the plaintiffs had been cut, we should be of opinion that the captain had done that which he was not entitled to do, and that the defendants were responsible for the injury so caused, but we are not satisfied from the evidence that the cable of the plaintiffs was cut." That, he assumed, was the whole point on which they lost their case. He supposed it would be possible for hundreds of ships to anchor, and never drag up two cables again, and he assumed that if in the future a ship fouled a cable, and those in charge of the vessel deliberately severed the line, the owner of the ship would be liable. A short time since a small ship fouled the company's cable outside Falmouth. The captain, on finding what had happened, slipped all his gear, and ran into port. He afterwards asked the company to pay the damages, which they did, as he had taken the right course. The company's cables, and landlines in connection with them, had continued in good working order throughout the year.

The resolution was seconded by Mr. J. Denison Pender.

A Shareholder commented on the satisfactory state of the balance-sheet, and the admirable manner in which the accounts were prepared.

In answer to Mr. Cochran, the Chairman stated that the traffic returns for January and February this year had been very favourable. No doubt trade must be affected in a country where there was an insurrection. There was a very large trade, however, between Cuba and the American States, and he thought that that trade would be more affected than the trade with England.

The motion was then unanimously adopted.

An extraordinary general meeting was then held, at which resolutions were passed to alter the articles of association to the effect that the retiring directors should be one instead of two.

Eastern Telegraph Company.—The directors announce the payment of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum, on the preference shares, for the quarter ending March 31st, and the usual interim dividend of 2s. 6d. per share, free of tax, on the ordinary shares, in respect of the profits for the three months ending December 31st.

Mevagissey Electric Light Company, Limited.—This company held its first meeting on 24th inst., Mr. C. M. Grier presiding. Mr. Hedly, the engineer, explained that the street lights were now completed, and the inauguration of the lighting of the streets would be celebrated the next day. He saw nothing to hinder the success of the company.

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending March 31st, 1896, of 12s. per cent. on the ordinary stock, and £1 4s. per cent. on the preferred stock, less income-tax, payable on May 1st to the stockholders registered on the books of the company on March 31st, 1896.

Stock Exchange Notices.—The Stock Exchange Committee have been asked to allow India Rubber, Gutta Percha, and Telegraph Works Company, Limited, £300,000 4 per cent. first mortgage debentures to be quoted in the official list in lieu of the £200,000 4½ per cent. debentures now quoted.

Oriental Telephone and Electric Company, Limited.—The directors have resolved to recommend, subject to final audit, a dividend for the year ended December 31st last of 5 per cent., free of income tax.

Cottonwood Water-Power and Electric Company, Limited.—The letters of allotment for the preference and ordinary shares were posted on Monday.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending March 22nd, 1896, were £952; week ending March 24th, 1895, £893; increase, £59; total receipts for half-year, 1896, £11,738; corresponding period, 1895, £11,716; increase, £22.

The Liverpool Overhead Railway Company. The receipts for the week ending March 22nd, 1896, amounted to £1,149; corresponding week last year, £943; increase, £206.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 20th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,694.

Competition.—In addition to the competitions previously referred to, the Société Industrielle de Rouen is also offering the gold medal of the Society for a new application of electrodynamic machines to the chemical industry. The competition, full particulars of which may be obtained from the Société Industrielle de Rouen, 2, Rue Ampere, Rouen, closes on September 30th next.

NOTES.

The Falcon Works Engineering Society.—An interesting paper was read before the above Society on the 18th inst. by Mr. E. H. Cozens-Hardy (student of the Brush Company) on "Röntgen Rays," in which, besides illustrating the subject by numerous lantern slides of very high quality, taken by himself with Mr. L. Cumming, of Rugby School, including one of the bones of the foot of a mummy; he also showed that he had made a close study of the subject since its first appearance before the world, and had made considerable independent research. Amongst other interesting points, he drew attention to the fact that the bulb of the Crookes tube, although containing no carbon, blackens similarly to that of an incandescence lamp, with this interesting difference: the blackening takes place only in front of the cathode disc, whereas, on the contrary, behind this disc, a gradual whitening of the bulb goes on; the tube, moreover, during the time that it is excited, becomes distinctly electrified, positively behind and negatively in front of the cathode disc. The author also drew attention to experiments he had made by means of photographing coins placed at different angles to the tube and at different distances from the plate, which, after careful measurements, seemed to show the rays to emanate from the inclined anode disc of the Crookes tube. He also stated that he had discharged a gold leaf electroscope at about 6 feet distance by means of the Crookes tube, a wooden partition wall intervening. A candle flame was found to be quite transparent to the X rays, and a possible trace of double refraction was obtained by the use of a rhomb of calcide. Practical demonstrations were given during the meeting, including the use of the cryptoscope. Mr. W. M. Mordey, who presided, congratulated the author on his paper and on his examples; they were at least as clear and interesting as those at a private address and demonstration he had attended a few days before in London, given by the scientific man who has done more than anyone in England to investigate this matter. It was a happy circumstance in connection with the Röntgen rays that their discovery was followed immediately by useful application. The subject interested everybody, ordinary people, scientific people and medical men; the latter, especially, were benefited. Several other members joined in the subsequent discussion.

The "Excelsior" Electric Battery.—One would have thought that in these days, when the public supply of current is becoming so general, the impossibility, from an economic point of view, of a primary battery in which zinc is consumed for electric lighting purposes, would have been evident to anybody with the slightest electrical knowledge. Yet, from a circular just to hand, it appears that a certain firm count upon there still being a class of persons willing to pay a comparatively high price for a battery, with all its attendant disadvantages, which are too well known to need enumeration. This battery is styled "the latest invention in the electrical world for lighting purposes," and by its means "a 1-C.P. lamp will not cost more than ⅓d. to ½d. per hour; *it is therefore much cheaper than gas.*" These are quotations from the prospectus, the italics being our own, and a more preposterous and incorrect statement than the latter of the two it is hard to conceive. An ordinary 5-foot burner will give 12 C.P., at a cost of not more than half a farthing per hour, and, of course, with Welsbach mantles, much greater economy is secured. And who is going to pay ½d. for a 1-C.P. electric lamp, when supply companies enable us to burn 16-C.P. lamps at less than that price per hour? The statement, too, that a 50 to 60 hours' run on a single lamp has never before been obtained by any battery for domestic lighting is distinctly untrue. The price of a battery and accessories for a 1-C.P. lamp is £3, and so on in proportion up to a 16-C.P. lamp, the battery for which costs £30! One charge is said to light *one* lamp from 50 to 60 hours, *i.e.*, *two* lamps for, say, 30 hours, and so on. Our doubts regarding this latest wonder are not lessened, when we read that the battery is also suitable for electric bells, telegraphic and telephonic work, electroplating, &c.

Edison and the "X" Rays.—The following addition to Lord Kelvin's letter which appeared in our last issue arrived too late for insertion:—"I may add that Dr. Macintyre, of Glasgow, tells me that he finds platino-cyanide of potassium better in respect to colour than the platino-cyanide of barium mentioned in Röntgen's original paper. He finds, however, that both salts give satisfactory pictures, visible instantly to the eye. It is well understood, of course, that both in Röntgen's original work and in trials and developments of it by others, it is only for recording results that photographs are necessary. Dr. Macintyre has constructed an arrangement for use in the Royal Infirmary of Glasgow, by which already in his own house he has examined bones of patients suffering from disease. A young friend of mine, not troubled with any illness, was allowed to see the ankle bones of his own foot without taking his boot off."

A *Daily Chronicle* correspondent points out that there is "absolutely nothing new" in Edison's discovery, by which he is able to examine the bones of the hand, &c., with the naked eye by means of a screen coated with tungstate of calcium. The writer refers to the experiments by Mr. Herbert Jackson, before the Chemical Society several weeks ago, in which he showed to the entire audience the bones of the hands, &c., on a phosphorescent screen, and stated that he had been able to examine his own spine by the same means, the only precaution necessary being to have an absolutely dark room. "Mr. Jackson used for his fluorescent screen platino-cyanide of potassium, and the only difference between his and Mr. Edison's experiments is that the latter replaces this by tungstate of calcium, a substance considered by experts in this country not to give such good results as the platino-cyanide of potassium."

City and Guilds Institute.—In the "Examination Questions in Electric Lighting and Power Distribution," now being published in *Electricity*, the following occurs:—"Why does an electro-magnet pull so much less if you take out the iron core and replace it with a brass one?" The answer is given that "the pull per square centimetre of an electro-magnet core is proportional to the square of the induction, and since the permeability of iron is very great, whilst that of brass may be taken as unity, it is obvious that the induction is very much greater with iron than with brass. Thus with a hollow solenoid the intensity of the magnetic field—denoted by H—is simply proportional to the number of ampere-turns, whilst with an iron core the intensity—denoted by B—is μ times H, μ being the permeability of the iron, and equal to 800 or more times the permeability of brass, air, &c. In fact, the iron core concentrates the H lines of force due to the magnetising force, and in consequence the iron becomes magnetised so that the H lines becomes B (B—H), lines being created." But should the question not have been, "Why does a solenoid pull so much less, &c." Take out the iron core, and where is the electro-*magnet?*

The Paper Making Machine as a Generator.—Referring to the letter of Mr. Henry Rogers, and our Editorial reply in the issue of 13th inst., we cull the following from Badt's "New Dynamo Tenders Hand-Book":—"Static electricity is generally caused by the friction of a dry belt on the dynamo pulley. This static electricity may sometimes prove a source of considerable trouble . . . . the filaments of incandescent lamps will be destroyed by static discharges from belts. The engineer of a large incandescent plant complained to the author that there was at least one spot in the wiring system of his engine room which surely had too high potential. An incandescent lamp would not live longer than half an hour in a certain socket . . . . the lamp was suspended over a dynamo belt. We took a piece of board, covered it with tin, drove a dozen or more nails through it, thus making a 'prime conductor with collecting spikes," and then connected it with 'earth.' The apparatus was placed under the belt, and operated quite satisfactorily in leading off the static electricity to earth." Mr. Badt mentions other instances where a similar appliance eliminated all the troublesome effects of the static discharge. Has Mr. Rogers tried such a device?

Light Railways.—We are sometimes asked to name a light railway of the kind we have referred to at various times, as capable of being constructed upon the "cess," or strip of grass bordering the road. We have already referred to the Upwell and Outwell line from Wisbech station yard to the villages of above name, and we might add the Wantage Tramway from Wantage Road station on the Great Western line to the town of Wantage, as another example of a line that could very easily be worked by the overhead wire system. At present this tramway is worked by small locomotives of the usual boxed-in tramway type. We are constantly over roads where the facilities for constructing such light railways are superior to those on the Wantage Road. Thus the high road from Brockley to Buckingham is a case in point. There is an exceedingly poor train service, and a road that might have been laid out with electrical railways in view at the time.

Autocars.—At Berwick, on 19th inst., the Hon. T. R. B. Elliot was fined 6d. and 19s. 7d. costs for driving an autocar through the streets.

A number of gentlemen interested in obtaining a change in the law regulating the use of locomotives on roads, on Monday attended the first sitting of the House of Commons' Committee on the subject in Committee Room No. 13. Mr. H. Hobhouse presided, and other members of the Committee are Sir W. Houldsworth, Captain Bagot, Mr. Griffith-Boscawen, Mr. Bill, Mr. Vaughan Davies, Mr. Seale Hayne, Mr. Herman Hodge, Colonel Kenyon Slaney, Sir J. Kinloch, Mr. Luttrell, Mr. Tully, and Colonel Warde. The first witness was Mr. Rotton, Legal Adviser to the Local Government Board, who came to give evidence on the existing law relating to locomotives and traction engines.

Electrical Engineering in the Tyrol.—Messrs. Ganz and Co., of Buda Pesth, have lately installed an interesting electric power transmission plant at Acherain, in the Tyrol, at the brass works of Messrs. C. Kulmiz & Co., where the machinery has previously been driven by water-wheels. Owing, however, to the low level of the river, there have been frequent stoppages, and to overcome the difficulty the above-named plant was decided upon. This comprises a 200 H.P. turbine, and a large dynamo. The electrical energy generated is transmitted to the works, where it is employed not only in the electric lighting of the works but in running, by means of two 60 H.P. electromotors the brass rolling mill.

Telegraphing without Wires.—A despatch from New York in yesterday's *Chronicle* says that Nikola Tesla announces that, "After experimenting for several years, he had come to the conclusion that it would soon be possible to dispense with telegraph wires, and to transmit messages to any place on earth, or even the nearer planets, by the scientific utilisation of electric waves"; and, as if we had not already enough to drive us mad in X rays, Mr. Tesla hopes ere long to demonstrate the practicability of his plan.

The Dolbear Patent.—We hear that the British Insulated Wire Company, owning the Dolbear 1882 patent for "Improvements in Electrical Cables," the prolongation of which was refused by the Lords of the Privy Council last week, has issued writs for damages against sellers and users of cable claimed to come under Dolbear's specification.

Electrical Engineer Wanted.—The West Ham Borough Council invite applications for the appointment of electrical engineer at a salary of £300 per annum. Further details will be found in our "Official Notices."

Paper. — Before the Fife Farmers' Club meeting at Cupar, on the 17th inst., a paper on "The Introduction of the Telephone to Farms," was read by Mr. Longmuir.

NEW COMPANIES REGISTERED.

London Electro-Plating and Refining Company, Limited (47,210).—This company was registered on March 13th with a capital of £1,000 in £1 shares, to acquire and carry on the business of electroplaters, enamellers, metal refiners, &c., carried on at St. John's Passage, Clerkenwell, by A. V. Pittar and A. Soden as "The London Electro Plating and Refining Company," and to adopt a certain agreement. The subscribers (with one share each) are:—E. W. Beckingsale, Beaufort-road, Surbiton, gentleman; A. Soden 141, Princes-road, Lambeth, electroplater; T. J. Pittar, Brior Walk, Putney, civil servant; A. V. Pittar, Brior Walk, Putney, electroplater; C. F. Pittar, Brior Walk, Putney, engineer; E. Thompson, 10, Marlborough Road, Lee, engineer; N. T. Beckingsale, 9, Copthall Avenue, E.C., solicitor. The number of directors is not to be less than two, nor more than seven. Registered by Beckingsale & Co., 9, Copthall Avenue, E.C.

Silicon Electric Lamp Syndicate, Limited (47,238).—This company was registered on March 16th with a capital of £8,000, in £1 shares, to test, investigate, and develop certain inventions connected with the manufacture of electrical lamps, for which patents have been granted to R. Langhans, A. Berrenberg, and E. D. Chaplin, and to carry on the business of electric lamp and apparatus manufacturers, electricians, engineers, &c. The subscribers (with one share each) are: H. L. Pilkington, 76, Jermyn Street, S.W., gentleman; P. J. Miller, 3, Pope's Head Alley, E.C., solicitor; T. L. Down, 3, Pope's Head Alley, E.C., solicitor; A. F. da Costa, 16, Hyde Park Gate, S.W., gentleman; F. D. Summers, Bolingbroke Grove, New Wandsworth, gentleman; W. H. Smillie, 6, Old Jewry, E.C., bank director; J. G. Bristow, 1, Copthall Buildings, E.C., solicitor. The number of directors is not to be less than two, nor more than five; qualification, £100; remuneration, £750 per annum, divisible. Registered by Wilson, Bristows & Carpmael, 1, Copthall Buildings, E.C.

Electro-Metallurgical Company, Limited (47,245).—This company was registered on March 17th with a capital of £100 in £1 shares, to acquire and work any patents for inventions relating to the production of chrome and other metals by electrolysis. The subscribers (with one share each) are:—L. Rogers, 44, Dalberg Road, Brixton, clerk; H. Williams, 79, Cavendish Road, Hornsey, clerk; E. Anderson, 4, Vauxhall Bridge Road, S.W., registrar; H. M. Williams, 261, Queen's Road, New Cross, accountant; A. Sapper, 64, Brailsford Road, Tulse Hill, clerk; E. W. Ebert, 76, Barrington Road, Brixton, clerk; S. W. Scullin, 26, Kathleen Road, Clapham Junction, clerk. Table A mainly applies. Registered by Faithfull and Owen, 11, Victoria Street, S.W.

United Electric Wire and Telegraph Works, Limited (47,260).—This company was registered on March 18th with a capital of £6,000, in £1 shares, to carry on the business of electricians, mechanical engineers, and electrical apparatus manufacturers. The subscribers (with one share each) are:—G. Whitaker, 22, Cloudesley Road, N., mariner; W. Coleman, 28, Alma Street, N.E., bachelor; P. M. Dickins, Thurlow Park Road, Dulwich, electrician: E. Watson, 154, Rushmere Road, Clapton, engineer; A. M. Martin, 32, Risinghall Street, N., electrician; H. Conduit, 13, Gloucester Road, S.W., electrician; J. Boss, 45, Lupus Street, S.W., bachelor. The number of directors is not to be less than two, nor more than five; the subscribers are to appoint the first. Qualification one share; remuneration as the company may decide. Registered office, 14A, Clerkenwell Road, E.C.

Cottonwood Water Power and Electric Company, Limited (47,196).—This company was registered on March 13th, with a capital of £210,000, in £1 shares, to adopt an agreement with J. E. Condict, and to carry on the business of a power company, an electric company, and a water company, at U.S.A. or elsewhere. The subscribers are:—F. Williams, Elm Villas, Kingston-on-Thames, gentleman, 250 shares; A. J. Filgate, 106, Jermyn Street, S.W., colonel, 250 shares; H. R. Savory, 18, Gleneldon Road, Streatham, gentleman, 250 shares; R. A. Fairclough, 9, Craven Hill, W.C., merchant, 250 shares; J. Boustead, 34, Craven Street, W.C., merchant, one share; E. A. King, 297, Winchester House, E.C., gentleman, one share; F. Stuttaford, 15, Clements Inn, E.C., gentleman, one share. The number of directors is not to be less than three nor more than seven; qualification, £250; remuneration, £150 each per annum, and a share in the profits. Registered by Reynols, Blogg & Co., Union Court, Old Broad Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Elmore's Patent Copper Depositing Company, Limited (28,053).—This company's annual return has just been filed. The capital is £220,000, in £2 shares (of which 8,905 are preference). All have been taken up, and 22,300 ordinary have been issued as paid. The full amount has been called on the others, and £153,400 has been paid. Fifteen shares have been forfeited, and £7 10s. paid thereon.

London Electric Wire Company, Limited (36,544).—This company's annual return was filed on February 26th. The capital is £50,000 in £5 shares (of which 5,000 are preference). 4,188 preference and 4,597 ordinary shares have been taken up, and 3,860 of each class have been issued as paid; £5 per share has been called on the rest, and £5,325 has been paid.

Lithanode Electric Storage Company, Limited (45,354).—This company's statutory return was filed on January 1st. 7,007 shares have been taken up out of a capital of £12,000 in £1 shares, and 5,500 of these are considered as paid; £1 per share has been called on 1,507, and £1,200 has been paid, leaving £307 unpaid.

Westminster Electric Supply Company, Limited (27,061).—This company's annual return was filed on March 12th. The capital is £400,000 in £5 shares; 68,000 have been taken up, £5 per share called, and £340,000 paid.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, March 18th.	Closing Quotation March 25th.	Business done during week ended March 25th, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	10½— 11	10½— 11	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	46 — 48	47 — 49	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	87½— 88½	89 — 90	89⅞	87¾
2,993,560£	Do. do. Defd.	Stock	...	...	...	7¼— 7¾	7¾— 8¼	7 15/16	7⅛
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	7 %	...	14¼— 14¾	14¼— 14¾	14⅜	14⅛
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1½%	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ — 13½	12½ — 13½	13½	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	106 —109 %	106 —109 %	...	..
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	...	9¼— 9⅝	9¼— 9⅝	9⅝	9⅜
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	...	17 — 17½	17 — 17½	17 1/16	17¼
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	...	18 — 18½	18 — 18½	18 1/16	18
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	105 —108	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	129 —132	129 —132	131⅜	131
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17⅜— 18¼	17⅜— 18¼	18⅛	17⅜
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	101 —105	101 —105	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	102 —105	102 —105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	128 —131	128 —131	128½	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	101 —105	101 —105	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	105 —108	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	112 —115 %	112 —115%	...	..
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝% §	4½%	...	10½— 10⅝	10½— 10⅝	10 13/16	10 7/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	...	16⅝— 17¼	16⅝— 17¼	17⅛	17
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝%	8⅝%	...	22¼— 23	22¼— 23¼	23	22⅞
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 —105	103 —106	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	47 — 50	47 — 50	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	...	106 —109	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5½%	6⅞— 7	6⅞— 7	7	6 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	17½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16½— 17½	16½— 17½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅝— 6⅞	6⅝— 6⅞	6 11/16	6⅝
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —108	105 —108	107⅛	106⅛
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	...	1/16— 1/8	1/16— 1/8	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	108 —111	108 — 111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	...	5 — 6	5 — 6	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	132 —137	132 —137	...	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	...	3½— 4	3½— 4	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	97 —102	97 —102	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	...	5½— 6½	5½— 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	1 — 2	1 — 2	...	.
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	94 — 99	95 —100	95	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	...	8½— 9	8½— 9	8⅞	8 13/16
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	6¼— 6⅝	6¼— 6⅝	6⅝	6 9/16
33,129	Do. do. do. Def. Ord.	7½	...	1 %	...	2¼— 2⅜	2¼— 2⅜	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	102 —106	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	102 —106	103 —107	...	..
88,321	West India and Panama Teleg., Ltd.	10	⅞%	¼%	...	1 — 1¼	1 — 1¼	1 3/16	1⅛
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	10⅜— 11½	10⅜ — 11½	11 1/16	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	108 —111	108 —111	109½	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	...	113 —118	113 —118	...	...
164,300£	Do. do. 6 % Stor. Bonds	100	6 %	6 %	...	102 —106 xd	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	7 — 7½	7¼— 7¾	7⅞	7 5/16
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7¼— 7½xd	7½— 8	7 13/16	7⅝
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4 %	116 — 119	116 —119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	14 — 15	14½ — 15½	15¼	14⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16 — 17	16 — 17	16 5/16	16⅜
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	134 —138	134 —138	135½	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8 — 9	8 — 9	8½	...
10,000	Do. do. do. 6% Pref., £8 pd., 40,001—50,000	10	...	...	...	10 — 11	10¼— 11½	11	10 13/16
50,000	†Liverpool Electric Supply, all paid	5	5 %	5½%	...	7⅞— 7¾xd	7⅞— 7¾xd	...	..
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	...	13 — 13½	12¼ — 12⅝	13¼	12⅝
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	118 —120	118 —120	117	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	8¾— 9½	8¾— 9½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	9¾— 10¼	9¾— 10¼	9 15/16	9⅞
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9¼— 9⅝	9¼— 10	9⅝	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	9½ — 10	9½— 10	9⅞	9⅝

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, March 18th.	Closing Quotation, Mar. 25th.	Business done during week ended Mar. 25th, 1896. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	5 % §	2½%	...	1¼— 1⅜	1¼— 1⅜	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	3 %	...	1⅝— 1⅞	1⅝— 1⅞	1⅞	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	110 —113	110 —113	...	...
630,000*l*	City and South London Railway	Stock	1 1/16%	1½%	1 3/16%	40 — 42	40 — 42	41	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 % §	*nil*	...	2¼— 2⅜	2¼— 2⅜	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	...	1¼— 1⅜	1¼— 1⅜	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	...	3 — 4 xd	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	...	103 —106 xd	103 —106	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	1¼— 1⅜	1¼— 1⅜	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2¼— 2⅜	2¼— 2⅜	2⅜	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	3/16— 5/16	3/16— 5/16	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	3/16— 5/16	3/16— 5/16	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil*	...	¼— ⅜	¼— ⅜	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	...	9½— 10½	9½— 10½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	16 — 17	16½— 17½	16⅞	16½
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	17 — 18	17 — 18	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	107 —112	107 —112	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	19½— 20½	20 — 21	20½	20
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	103 —105	103 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅞%	13⅞— 14⅛	14 — 14¼	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16⅜— 16⅝	16⅜— 16⅝	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	38 — 41 xd	38 — 41	39½	38¼
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	6 — 6½	6 — 6½	6⅝	6½

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50°/ for 189
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0°/₀; 1891—7°/₀; 1890—8°/

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅞—6¼.

Electric Construction Corporation, 6 % Debentures, 103—106.

House-to-House Company (£5 paid), 3¼—3½.

Do. do. 7 % Preference, of £5, 8—8¼.

Do. do. 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 8¼—8⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 7¼—7⅜.

Liverpool Electric Supply, £5 (fully paid), 7⅜—8¼.

London Electric Supply Corporation, £5 Ordinary, ⅜—½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅜—7¼.

Bank rate of discount 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

High Voltage Lamps, and their Influence on Central Station Practice. By G. L. Addenbrooke, Member. Paper read February 27th, 1896.

(*Concluded from page* 397.)

It may be useful here to give a few general data relating to accumulators as they stand at present.

The leading makers' prices of central station batteries work out at about £13 per kilowatt on a discharge for three hours, for the plates, cells, and acid only; whilst, including stands, erection, connections, and switching arrangements, the price works out about £17 per kilowatt, or, if buildings also are included, about £19 per kilowatt.

In such a battery, I find the plates and lead cells alone would weigh about 8 cwts. per kilowatt output on the three hours discharge basis; and that 1 cwt. of plates and cells costs a little under £2, or the cost comes to about £40 per ton. Now, as lead costs under £12 per ton at present, and seeing how much almost pure lead, in a very simple form, there is in accumulators, it does not seem unreasonable to anticipate that in the future, when accumulators are made on a much larger scale, we may see the price gradually come down to, say, £25 per ton, with, perhaps, improved capacity and life. At least, it appears to me that there is as good hope in this direction as there is of reduction in price and improvement in quality in any other department of electric engineering. If such a consummation were attained, it is pretty clear that it might pay to use accumulators for power stations, as well as lighting, wherever an eight or nine hours day was in vogue, and that they may ultimately come to exercise a much wider influence on the future of the electric industry than most engineers have anticipated.

In order to gauge in some measure what has been the improvement in accumulators during the last few years, and since the question of the system of central station supply was last prominently before this Institution, I lately took an opportunity of talking the matter over with Mr. Epstein, and I asked him if by looking up old contracts and catalogues he could give me anything definite on this subject. In reply, he has sent me the following letter:—

"I have looked into the question of the prices of accumulators, and I find that, comparing the prices in 1890 with the present ones, there is, on an average, a reduction of 25 per cent.

"But another and more important point is this—that whereas the types then manufactured were only allowed to be discharged in about 10 hours, necessitating, in the case of shorter discharges, much larger batteries than required for the purpose, the discharge rate has since then increased very considerably.

"Taking one with the other, I think I am justified in saying that the reduction altogether amounts to quite 50 per cent."

In view of these facts, and considering that it is now the custom to buy accumulators on a moderate maintenance agreement, and also all the added experience of the last five years' work, it will be at once evident on how much sounder a basis commercially accumulators now rest, and how much stronger the arguments in favour of their employment in central stations are than they formerly were.

Upon the three hours discharge basis I find a kilowatt capacity of accumulators occupies approximately 4 cubic feet space, for the cells and connections, so that we get a kilowatt-hour into 1·33 cubic feet. Now a discharge of a kilowatt-hour, allowing for losses, will keep about 15 16-C.P. lamps going for one hour. Allowing that a gas burner, using 6 feet of gas per hour, is equal to a 16-C.P. lamp, the amount of space needed in a gasometer to store gas for the same amount of light is 6 × 15 = 90 cubic feet, or 70 times as much space. Of course this is not quite a fair comparison, because nothing is allowed for stands, access, &c.; but I think it will be quite fair if we allow 10 times as much space for access, &c., as the accumulators take themselves. Even under these, the actual conditions, accumulators only occupy one-seventh the space which the equivalent gasometer would. We arrive, therefore, at the curious conclusion that, if the London gasometers were emptied of their gas and fitted up as accumulator rooms, sufficient accumulators for lighting London could easily be arranged under working conditions in one-seventh of the space which would be available. We have, therefore, nothing very enormous to fear in the way of accumulator houses, even if accumulators are used in the future on the most extensive scale for lighting or power purposes.

Interesting as these speculations are, it is desirable, however, to return to what is more specifically our subject.

It is usual at present to place the accumulators in the central station, except in a few instances, such as in Mr. King's system at Chelsea, Mr. Parker's Oxford system, and a few special places. Usually, under these circumstances, the accumulator is subject to the heavy drop at full load, which decreases its efficiency by 10 to 15 per cent.

With 220-volt lamps the drop on the feeders within a mile radius

would be much less than is usual now, and therefore the value of the accumulators would be correspondingly increased.

For longer distances from the central station than a mile, however, undoubtedly the right place in most cases for accumulators will be at the feeder points. This is the more feasible with 220-volt lamps than under present practice, because the distributing network is so much larger from each feeder, and each feeder becomes the centre of a serious amount of lighting, which will pay for individual attention.

Although from the table I have given the cost of copper per lamp installed for feeders is very moderate, yet on a two-mile feeder it amounts to a considerable sum in the aggregate; and if, by installing accumulators at the end of the feeder for one-third to half the full output, the section of the feeder can be cut down by one-third or a half, a very important saving is effected; and of course, if accumulators for two-thirds or three-fourths full load were installed, the cost of feeders would be correspondingly reduced.

This has already been recognised in practice, and many devices have been brought out for charging accumulators in series, or by the help of motor transformers using a high tension current; but I would point out that the use of 220-volt lamps on a three-wire system does away with the necessity for any of these complications. All that is needed is a continuous current motor transformer of the "booster" type.

In this, one armature circuit is across the mains, and wound with a high resistance and many turns, while the current to the accumulators passes through the second circuit direct; the second circuit being wound with a few turns, so that the voltage of the main current in passing through the armature is raised, say, 30 per cent. The motor transformer then need only be about one-third the capacity for the charging current, and the cells can be charged at any time, while the circuit is supplying lamps, so that continuity of supply without complication is ensured.

By these means the cost of long feeders would be much reduced on the figures given above; which means, also, that it would be practicable to extend the lighting radius much further than was contemplated above the same cost, should it be needed.

An important factor is also brought in—that, having once laid a feeder of fair size, accumulators can be added at the outer end as the lighting grows, and thus a very large increase of lighting could be gradually met without relaying the feeder or disturbing the streets, which is always an expensive and troublesome operation.

In what I have said above, I have indicated a feeder to each half square mile as an average, or four to the square mile; but it is clear that, if accumulators were employed, and it were desirable to concentrate them in order to save labour and attendance, it would be very simple to run short sub-feeders from a centre, so that one distributing point where accumulators were situated, and one feeder from the central station, could be economically made to serve a square mile or more.

It is further worth noting that at 220 volts the cutting in or out of a cell makes less than 1 per cent. difference in the voltage, and not 2 per cent., as at present. This is an important consideration in keeping the light steady—a point the importance of which is becoming more and more recognised.

The convenience of the system for arc lighting does not need pointing out, as nine arc lamps can be run in series.

One more point is the effect which a general electric supply at 220 volts on the lines indicated above would have on the power supply question.

There is no difficulty in procuring already motors of any size, from 50 watts upwards, to run on 220-volt circuits, the number of amperes they take being, of course, half what is usual now; while for larger sizes, say above 3 or 4 kilowatts, they could, of course, be coupled across the two outers at 440 volts.

If we then add the facts that the drop on the feeders would be less than at present, that the current-density in the distributing system on the basis I have laid down would only be about half what it is at present—and when we consider that there would only be 1½ per cent. fall of pressure at full load on the distributing mains, and that by cross-coupling even this would be reduced—then it seems to me that it goes almost without saying that motors could be used to a far greater extent than at present is possible without appreciably affecting the regularity of the lighting. Accumulators at the feeding points would also be an important aid in this respect; if they were so used, the fall of voltage from them to the motors would rarely exceed 2 per cent., and under such circumstances motors of considerable size could be started and stopped (even without special starting resistances) without the rush of current being perceptible on neighbouring lamps. In this respect, therefore, the use of 220 volts is likely to be very advantageous, and do away with the necessity of having to lay special power mains—for some years, at any rate.

The utility of having generators in the lighting stations giving the current and voltage which is needed for tramway work is also obvious; in fact, it looks as if one station in future would do all the power supply for a town, the lighting being only one adjunct of its business, and that, possibly, not the largest. With most of the lighting done by means of accumulators charged during the night, and the station supplying power to the tramways, &c., during the day, it ought to be possible to secure a very fairly even all-day load with one set of plant, instead of two, as at present. This would, of course, lead to important economies in generating expenses. In fact, it looks as if we could already see far enough ahead practically to enable Mr. Preece's prophecy to be fulfilled in a moderate time—"that the electric light would ultimately be the light of the poor man as well as of the rich."

And now I must conclude. The title of my paper was "High Voltage Lamps and their Influence on Central Station Practice."

In the first place, I have endeavoured to show that high-voltage lamps are thoroughly practical. Next, that high-voltage lamps are more desirable than lamps of the usual voltage and of high economy. I have also shown reasons why it is probable that the economy of high voltage lamps may in time nearly approach that obtainable in ordinary voltage lamps.

Having thus tried to establish the soundness of the position of the high voltage lamp itself, I went on to consider what influence the adoption of a high voltage lamp would have on central station practice.

I have shown how it simplifies and renders less costly the distribution of current, and how it improves the conditions of lighting. I think I have further made it fairly clear that for nearly all practical requirements of town lighting the direct supply system will prove simpler and less costly, as well as more advantageous, than any system, whether direct or alternating, in which transformers are used; in fact, the necessity for this class of apparatus, except for special cases, seems to vanish.

I think, therefore, that, when the facts are fairly faced, there does not seem much doubt that those engineers who have advised their clients to erect continuous current direct supply stations in the past have done wisely, and will be found to have served their clients' best interests; and that for the future alternating current stations, even for country towns and scattered districts, should only be erected after the most careful weighing of possibilities.

It is considerations of this character which have led me to keep very much in the background as regards central station lighting for the last four years. Having been associated from the early days with alternating currents, my predilections were in that direction; and although the position seemed secure, yet, seeing the possibility of great improvements in several directions which would tell strongly in the favour of direct supply (but the exact advent of which no one could actually foretell until it arrived), it seemed to me more prudent to turn one's attention to other things for the time, than to incur the risk of recommending work which might soon have to be undone.

I have always expected and looked forward to a time when there would be one system of lighting, with variations merely in details, and have felt that the rivalry between the two systems would some day end as the battle of the gauges ended in the early railway days; and I think there are signs of the end now. It seems as if the narrow gauge would win again—as if the tortoise would again beat the hare, though it is true that to do so the tortoise has had to improve its pace considerably.

At the ordinary general meeting of the Institution, held at the Institution of Civil Engineers, 25, Great George Street, Westminster, on Thursday evening, March 12th, the President, Dr. John Hopkinson, F.R.S., occupied the chair.

The formal business having been transacted,

The President said the business of the evening was to discuss the paper of Mr. G. L. Addenbrooke, read at the last meeting, on "High Voltage Lamps and Their Influence on Central Station Practice."

Mr. J. W. Swan said Mr. Addenbrooke's paper raised the question whether the time had not come when electrical engineers might arrange their plans for general electric supply, on the assumption that incandescent lamps adapted to a voltage double that now in vogue, would be forthcoming on demand, and whether there was good reason to believe that lamps of that kind would be as cheap and as good as the lamps for lower voltage. His paper raised other questions; in fact, it traversed a very wide field, and was very suggestive and interesting in many ways. Bnt he was only going to speak, and that very briefly, on the point he had mentioned, and as to high efficiency. He passed over the question, as Mr. Addenbrooke had done, whether there was a possibility of a different kind of lamp, a lamp, for example, of the Crookes tube or Tesla type, superseding the lamp now known. No one would be bold enough to say that a revolution of this nature was impossible; but at least it might be said that the symptoms of its near approach were not sufficiently marked to make it necessary for the electrical engineer to take the consequences into immediate account. It was, without doubt, a question of the greatest moment whether incandescent lamps of low C.P., and requiring a voltage of something like 200 or 220 volts, could be made to compete, in point of efficiency and cost, with lamps for the lower voltage now in common use. The demand for such lamps was comparatively a new demand, and as yet it was not a large one; but it was increasing, and the pressure was already sufficiently strong to compel the most strenuous efforts to meet the demand in the way it was required to be met, viz., by the supply, at a moderate cost, of a lamp for double the voltage hitherto employed, and that should have a fairly long life at a moderate efficiency. He thought that was very nearly the way in which Mr. Addenbrooke stated the question. Mr. Addenbrooke had told them that it was already possible to buy fairly good lamps of 8 and 16 C.P. to suit from 200 to 250 volts. The lamps shown appeared to bear out that statement. From his own experiments he knew that it was possible not only to fulfil the very moderate requirements stated by Mr. Addenbrooke, but to go considerably beyond them, and as time went on, the difficulties which attended a new departure of that kind would undoubtedly decrease, and the result would be both increased efficiency and diminished cost. But in the meantime it must be remembered that the 220-volt 8-C.P. lamp was a more fragile thing than the 110-volt lamp of the same C.P., as at present made, and rather more costly to manufacture. Looking at the question from the point of view of the electrical engineer instead of that of the lamp manufacturer, it was fairly clear that these drawbacks had a sufficient, and perhaps more than sufficient, compensation in the additional facilities they gave for a wider and more economical distribution of current from supply stations, a most important advantage, and one well worth making some considerable sacrifice to gain. But he hoped the ardour for progress in that direction might not lead to the adoption of lamps requiring double the voltage of the lamps now in use in connection with already existing installations, except after the most thorough overhauling of all portions of the installa-

tion, including the wiring of the houses, coupled with the introduction of every safeguard against fire that good design and good work could give. In new work, he saw no other objections to high voltage lamps such as those they had now in view, than those Mr. Addenbrooke had named. He had given two years for the thorough elaboration of the higher voltage system; it was a very liberal allowance, so far as the lamp manufacturer was concerned. He did not require it. If it was decided that, on the whole, higher voltage was necessary for the wider development of electric lighting from central stations, the lamps to suit the higher voltage would be duly provided whenever they were wanted, even if the time was now. To go from the question of high voltage to that of high efficiency, the real difficulty connected with the employment of lamps at a higher efficiency in watts per candle was not so much in the lamps themselves as with the conditions under which they were generally used, both in connection with the private and public supply of current. The fluctuations of pressure to which lamps were subjected were commonly too great to give a high efficiency lamp a fair chance of life. At 2½ watts per candle the filament was of course heated to a very high temperature, and any rise in voltage above that which produced the 2½ watt efficiency was very trying to the life of the lamp; in fact, they all knew that even the best lamps of that character would not bear for long any extra pressure, producing a super high efficiency and a super high temperature. The published charts made by the recording voltmeter showed that in the case of nearly all the public electric supply companies the normal voltage was often exceeded by more than 5 per cent., sometimes by even 10 per cent. When such extra pressure was brought to bear on lamps at the high efficiency of 2½ watts per candle, the result was disastrous—the lamp gave way. But given a voltage that never rose more than 1 or 2 per cent. above the normal point, there was then no difficulty in realising that degree of economy of current which Mr. Addenbrooke had described as obtainable by the use of 2½ watt lamps. Things would doubtless greatly improve in this respect, and he therefore hoped that in the near future it might be practicable to make a much more general use of lamps of high efficiency than under existing circumstances would be either convenient or economical. He trusted as everything that tended to the lessening the cost of electric light was to the general advantage, and promoted increased use, that the occasional and temporary loss of revenue that would result from the more economical use of current by means of lamps of higher efficiency would not either be thought or found to be against the ultimate interest of electric supply companies.

Mr. C. H. Stearn said that with the general tenour of Mr. Addenbrooke's paper he fully concurred, if in a few minor points he ventured to differ from his conclusions. All interested in the extension of electric lighting could not but feel a deep debt of gratitude to Mr. Baynes for the courageous experiment he had tried at Bradford under such very difficult circumstances, and had carried through to so triumphant a conclusion. Mr. Addenbrooke also by his pen had rendered great service to the new movement by bringing clearly before the minds of many who had not previously given much attention to the matter, the great importance of the economical results that would follow from the general adoption of the system of high pressure in central station practice. Mr. Addenbrooke was certainly very early in the field as an exponent of the new doctrine, and was fairly entitled to the credit of having been one of the early apostles of the system. With Mr. Addenbrooke's view that economy in lighting could be more easily reached by high pressure and low temperature than by high temperature and low pressure, he fully agreed, inasmuch as in the former case they had not the same difficulty which the descent in light of high temperature lamps presented, while at the

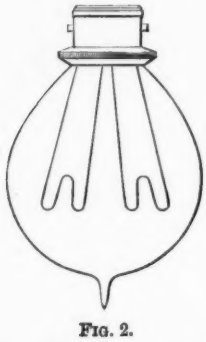


Fig. 2.

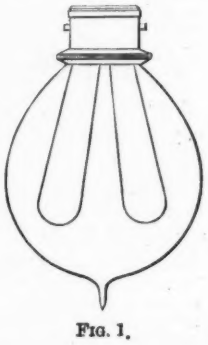


Fig. 1.

same time they had, or were likely to have, a more equably maintained pressure on the lamps themselves. As to duration, he must differ from Mr. Addenbrooke in the view that increased pressure necessitated any diminished duration either in 16 or in 8 C.P. lamps. Careful experiment had shown that the duration at equal temperatures (at least at temperatures corresponding to 3·5 to 4 watts per candle), was, if the filament was homogeneous, independent of its sectional area; that is, within the limits of 1,200 to 1,400 hours. He had not followed the experiment further than that, as it had no practical importance after that time. Dealing with the same efficiency, in the comparative trials to which he referred, the lamps of 8, 16, and 6 candles, at 200 volts, gave similar results, the majority still surviving after 1,100 hours. If, in commercial lamps, this result was not always confirmed in the thinner filaments, that evidently arose from preventible causes. But certainly, as far as the 16-candle lamps were concerned, the commercial results far exceeded those obtained in the tests he referred to. As to descent in C.P., that also had been ascertained to be the same for the same type of carbon at 110 as at 220 volts. The difficulties in the way were purely mechanical, and had to be overcome by a change in the mechanical construction of the lamp, so as to give greater stiffness to the filaments, and to render them self-supporting. The defects in some earlier forms of double filament lamps (fig. 1) were, that they were unsuited for using out of the vertical position, as installers, though they do not expect the laws of gravity to be suspended in their favour when dealing with gas, have decided that the lampmaker must be able to so completely triumph over gravity that his lamps can be used in any position. The later form shown on the board through the greater stiffness of the filament obtained by the M form would bear being used out of the vertical without falling and touching the glass (fig. 2). Some of these had run for over 800 hours in a horizontal position without any perceptible drop of the carbon. Though the double filament lamp was on the whole the best as a transitional form, yet no doubt the single filament, if it could be made sufficiently rigid and self-supporting, would ultimately become the typical form. He showed on the board some single filament lamps which were an attempt in that direction (fig. 3). The long life which was obtained at efficiencies of 3·8 to 4 watts (2,500 to 4,000 hours in some cases) showed clearly that they could move with ad-

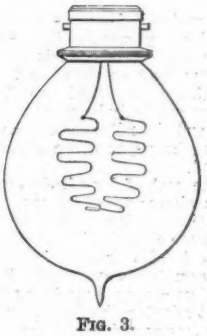


Fig. 3.

vantage in the direction of higher efficiency with perfect safety. But at the outset it was well to first establish perfect confidence in the durability at the lower temperature, and then gradually to pass to the higher efficiency. With the construction of the lamps on the lowest row, suggested by Mr. Topham, low specific resistance carbon, with its increased length, could more easily be dealt with, and in that way a higher efficiency could be obtained without any increase in the rate of descent in C.P. The movement had now gained such strength, that there was little fear of its opponents being able to resist its progress. The same objections now raised as to the diminished life of lamps at doubled voltage were raised at the outset in 1891, when they passed from 50 to 100 volts. The same objections as to lamps of 8 candles were raised a year or so later when wax 8 candle lamps of 100 volts were placed on the market. But for all that the 100 volt system had displaced the 50 volt, as it in its turn would be displaced by its double. The 8 and the 6-C.P. of 200 to 230 volts, he ventured to prophesy, would be firmly established in popular favour this time next year, and they would all wonder why they had made so much difficulty over so simple a matter.

Mr. T. A. Rose said he would simply give his experience of high voltage lamps, and that was that he found very little trouble in the manufacture of them. Of course a little more care was required. Still, his company had been very successful, and had supplied the lamps to several places, such as Wolverhampton, Manchester, and Bradford, from which places they had had very flattering reports, and increased orders.

Mr. J. F. C. Snell said: At the King's Road Station, St. Pancras, the lamps were running entirely at a pressure of 220 volts. They had a three-wire system with 440 volts between the outers, and at the present moment there were about 4,000 lamps fixed, the greater number of them having been running for five months. They had had very little trouble indeed with them, and he did not think the consumers really knew the difference between the 220-volt and 110-volt supply. His experience caused him to think that manufacturers ought to make some difference in the cut-outs and holders; it was in the holders that they got the chief difficulties. There was either short-circuiting between the contacts, or between the contacts and the brass case. With reference to the life of the lamps, he had had some running at his own house for over 1,300 hours and this would compare very favourably with 100-volt lamps. One point struck him in regard to the use of this higher pressure, and that was that under the new Board of Trade rules they would certainly have to earth the centre wire on a 440-volt system. At the Manchester meeting of the Institution of Mechanical Engineers, it was stated that they had a considerable leakage at Manchester between the balancing wire and the negative, and he did not know how they were going to get over that. Of course, that was a condition which would not obtain with a 110-volt supply. With regard to the steadiness of line, the Board of Trade now permitted them to vary to the extent of 3 per cent. above or below the standard pressure. On a 440-volt supply (that was, a three-wire system with 220 volts on each side of the balancing wire), he thought it would be very much easier to maintain a greater steadiness of pressure with a less "percentage variation" than was now obtained with a 110-volt supply.

Mr. C. J. Robertson said the troubles his firm had found with high voltage lamps up to the present were practically nil, except in

the case of the workpeople, who had to handle the lamps in the course of manufacture. They had to use low specific resistance filaments, which were, he imagined, the only practical filaments to be used. Beyond that he pretty well agreed with what Mr. Swan and Mr. Stearn had already said. The Incandescent Electric Lamp Company had had very small experience with such lamps, but they were perfectly capable of converting all their manufacture instantly to 200 or even 300 volts if required. The danger which he had pointed out in the manufacture was one which each manufacturer would be able to get over as he was called upon to deal with higher voltages.

Mr. GEIPEL said, before he read Mr. Addenbrooke's paper, he was under the impression that, granted the 200-volt lamp was successful, it was all up with transformer systems; but if all Mr. Addenbrooke said was true, then he thought those of them who had devoted years to the perfecting of these systems, might feel that there was a vast field of use still before the results of their labours. In fact, he had been wondering whether Mr. Addenbrooke had or had not been slyly giving his old friend "a leg up." He thought they were many of them indebted to Mr. Addenbrooke, in the first place, for the care he had taken in showing them that even with the three-wire and 200-volt lamps, and the station planted in the centre of the town, the low pressure direct supply system for distributing apparatus alone cost £60 per kilowatt. He was quite sure that, on the alternating transformer system, with 100-volt lamps, this figure would cover the cost of the whole works, including buildings, generating plant and distribution. It required no words of his to emphasise the singular importance which the first cost had upon the cost per unit; but he might remind the members that they would find an interesting curve showing this relation in his contribution to the discussion on Mr. Crompton's paper on the cost of electrical energy (Vol. xxiii., p. 478), in which they would see that, taking a given sum for works' cost, the total cost per unit varied from about 3¾d. when the first cost of plant was 2s. 9d. per unit sold, to 1¾d. when the cost was 6d. He thought, therefore, that if Mr. Addenbrooke's estimate was correct, the transformer system would give a cheaper supply with a 100-volt lamp than the direct system would with a 200-volt lamp. In addition to that he saw that Mr. Addenbrooke calculated his £60 per kilowatt for distributing from the centre of a town radially in all directions, so that, excepting in unusual cases, there was the increased expense of working as compared with the high tension station, which might, of course, be situated more favourably. It was a matter of fact that at least one of the important direct supply stations in London had decided to remove from the centre of the district to a spot entirely outside, so that, at any rate in that case, they appreciated those expenses and difficulties, while Mr. Addenbrooke's calculations as to first cost presumably would in such case be increased. He did not believe, however, that the 200-volt lamp was the correct lamp to use, in fact he quite agreed with Mr. Addenbrooke that it was in the tentative stage, and he feared it would remain there for many years to come. They all knew that, apart from all questions as to economy in watts per C.P., and as to the necessity of small C.P., lamps could be made and used successfully very much higher than 200-volts, but then people could not all afford to use Sunbeam lamps in their little dark corners, especially in those places which required artificial light all day. The question, to his mind, resolved itself upon the 8-C.P. lamp. People ought to have the advantage of using such lamps without wasting half the energy by burning another lamp in series with it as had been suggested, for they might just as well use the 16-C.P. lamp at once. Could lamp makers produce a good 200-volt lamp of 8-C.P, which would last 600 or 700 hours with a strain of 3 watts per candle? His experience was that they could not do it, and he knew one of the leading makers who candidly admitted it. He doubted if it could be done with less than double that strain; indeed, it was difficult enough to obtain efficient 100-volt 8-C.P. lamps which would stand, satisfactorily, the ordinary varying pressure of an electricity supply works. A great deal was made of the improvements which had taken place, and which might be expected in lamps; he would be a bold man who stated that advance were an impossibility; but had that wonderful improvement actually taken place? Ten years ago good 100-volt 16-C.P. lamps could be obtained using 4 watts per candle, and lasting 1,000 hours. It might be that strain had been reduced to 3½ watts per candle for a similar life, but he thought that was about the extent of their improvement. Of course the price had been so much reduced that it paid to use lamps at a higher efficiency, but the improvement in the quality did not appear to be so wonderful. For his part, he thought the 200-volt lamp policy a mere subterfuge, which should be strongly opposed. Why were people adopting the Welsbach gas burner? Simply because they got a good light for half the consumption of gas. If, then, they wished to compete with the Welsbach, and it was a serious competition, they must give the consumer a lamp which took less watts; in fact the tendency, if anything, should be to reduce the 100-volt supply rather than to increase it to 200 volts, for he thought no one would deny that with the lower voltage more efficient 8 C.P. lamps could be made. It was his opinion that the popularity of the electric light would be distinctly and unfavourably affected if they forced upon the consumer a 200-volt supply.

(To be continued.)

Physical Society.

ORDINARY MEETING.—MARCH 13TH, 1896.

(Prof. CAREY FOSTER, Vice-President, in the chair.)

Mr. J. H. REEVES read a paper on AN ADDITION TO THE WHEATSTONE'S BRIDGE FOR THE DETERMINATION OF LOW RESISTANCES.

The piece of apparatus described can be used for measuring the resistance of metre lengths of wires of low resistance, the only additional apparatus required being a sensitive galvanometer, a Post Office form of resistance box, and a metre bridge. It differs from the ordinary Kelvin Bridge in that instead of balancing by varying the length of the standard wire between the two contacts, the distance between these contacts is maintained constant, as is also the length of the wire which is being measured, and balance is obtained by altering other resistances in the network. The author has made a number of tests which show that by his arrangement the resistance of metre lengths of copper wires between the limits of No. 22 S.W.G., and a stranded cable of seven No. 16's, can be determined with an accuracy of 0·1 per cent.

Mr. REEVES also read a note on the exact value of Matthiessen's standard.

Prof. A. GRAY (communicated) said that the author had in his arrangement combined the fixed standard employed in Matthiessen and Hocking's modification of the ordinary bridge with the greater celerity of working arising from the smaller number of operations to be performed when the Kelvin bridge is used. Prof. Gray thinks that he, and probably others, has used a method similar to that of Mr. Reeves, but that the paper is of great utility, since it shows how time may be saved and existing apparatus utilised.

Prof. AYRTON said that the advantage of the method described lay in the fact that it was independent of the resistances at the contacts. In Carey Foster's method, however, the coils had to be interchanged, and inaccuracy might be introduced, owing to the varying resistance of the mercury contacts. Unless the mercury cups and the copper plates at the bottom were cleaned every day, and the contacts reamalgamated, the resistance of the mercury cups was very variable. With regard to the question of Matthiessen's standard, it is to be remembered that the specific conductivity of copper has been steadily increasing. Fitzpatrick had explained the rise in conductivity of copper by supposing that the density of the copper now supplied was greater than that of the copper used by Matthiessen, and this explanation seemed quite satisfactory. Mr. Reeves's experiments, however, have conclusively shown that this is not the true explanation. It was now possible to obtain copper in large quantity having a conductivity of 103 on Matthiessen's scale.

The CHAIRMAN (Prof. Carey Foster) explained how, when using his method, the accuracy of the result depends not on the elimination of the small resistances at the mercury cups, but on the constancy of these resistances. Matthiessen and Dr. Russell found that the specific gravity of copper was apt to be low on account of the presence of dissolved oxide, and they were the first to pass hydrogen gas through the molten metal to remove this oxide.

Mr. CAMPBELL said that it ought to be definitely settled whether Matthiessen's standard was the conductivity per unit volume or per unit mass. Since copper was always bought by weight he, as a practical man, strongly advocated the adoption of the mass conductivity, for in this case the measurement of the specific gravity would be avoided.

A communication by HERR PULUJ on CATHODE RAYS was read by the SECRETARY.

HERR PULUJ exhibited some Röntgen photographs taken by means of a form of Crookes tube which he had described in a memoir published in 1889. With this tube he has succeeded in obtaining impressions with exposures of only two seconds. Herr Puluj considers that the particles of matter torn from the cathode, which convey negative electrostatic charges, by impact on the glass walls, or on screens, equalise their electric charges, and in this process call forth not merely a disturbance of the material molecules, but also of their ether envelopes. Each portion of the glass or screen bombarded by the cathode stream becomes the starting point of ether waves, which, according to their oscillation period and oscillation character, are either visible rays (phosphorescence) or invisible Röntgen rays. The oscillations of the invisible rays may take place in the longitudinal direction, but no convincing argument has up to now been brought forward to support this view.

The SECRETARY also read a note on PERMEABILITY TO RONTGEN RAYS, by Messrs. ACKROYD and KNOWLES.

The authors have exposed a plate on which a number of pieces of metal, anides, and sulphates were placed to the Röntgen rays in order to see whether the permeability of bodies to these rays depends on the atomic or molecular weight of the body. In each case it was found that the opacity increased with the molecular weight.

Mr. BLAKESLEY said that he considered the Röntgen rays to be the propagation of electrostatic strain through space. With reference to the non-refrangibility of these rays, he had observed in one of the photographs exhibited by Mr. Swinton a dark line at the edge of the shadow of a wooden pencil, which might have been due to the refraction of the rays by the wood. Mr. Blakesley has, however, found that this line is due to the varnish on the pencil. Some Röntgen photographs of quartz and ebonite rods not only did not exhibit these dark lines, but there was a very slight indication of a bright line just on the edge of the shadow, which would indicate that the refraction of these rays was less in the rods than in the surrounding medium.

Mr. EDSER exhibited some photographs taken with Mr. Jackson's form of tube, in which a concave cathode is employed. Mr. Edser said that the whole of the tube on the cathode side of the anode plate phosphoresced, so that the Röntgen rays seem to partake of the character of diffused light.

Prof. AYRTON said Mr. Jackson had found that the cathode rays form a parallel beam, and do not first come to a focus and then again spread out.

Mr. BLAKESLEY described the tube used by Puluj, in which a mica screen coated with green calcium sulphide is placed between the cathode and the anode.

Mr. GARDNER said that there seemed to be some confusion, for when a concave cathode is employed the cathode rays are brought to

a focus, and then again diverge. The phosphoresence on the inside of the glass had been shown by Lenard to be due to electricity travelling round the inside surface of the glass.

Mr. Pidgeon asked if anyone had tried the effect of mounting the photographic film on a metal plate?

The Chairman said that Captain Abney had found that if the film was mounted on a ferrotype plate, no action took place.

Prof. Perry said that he, for one, was of opinion that the Röntgen rays were undulatory. Prof. Larmor has given an explanation which seemed to agree with the observed facts. This explanation supposes that the intermolecular spaces respond to vibrations of a certain frequency. The reason no refraction or diffraction effects had been observed was probably because of the extreme smallness of the wave length of the undulation.

REPORT ON DR. LESSING'S DRY BATTERY

Dr. R. Mullineux Walmsley, F.R.S.E., M.I.E.E., &c., Professor of Electrical Engineering at Heriot-Watt College, Edinburgh, has just issued a preliminary report on Dr. Lessing's dry battery as follows:—

During the last few years the advantages of the so-called dry cells, as compared with other forms of primary batteries, have become more and more recognised by users of small electric currents, especially when employed intermittently as in telegraphy, telephony, medicine, ringing electric bells, &c., &c. These advantages have been discussed and admitted generally in the technical press, and it is, therefore, unnecessary in this preliminary note to refer to them in detail. Dr. Lessing's cells belong to the well-known type of modified Leclanché cells, the depolariser being black oxide of manganese and the exciting fluid sal-ammoniac. Each cell is contained in a neat porcelain outer cylinder or jar highly glazed, and is securely sealed up; lugs on the carbon and zinc plates project through the seal and are provided with convenient binding screws for making connections. The height of each cell is 6·3 inches and its external diameter 3·1 inches, whilst the weight averages about 3 lbs. 2 ounces. The arrangements for so sealing the cell that the moisture cannot creep or escape, and the necessary vent for the gases that may be set free, appear to be admirably adapted to the objects in view, and have responded very well to the preliminary tests. Further tests designed to break down these arrangements will try them still more severely. The following tests were made upon three cells taken at random from a large parcel. The electromotive force (E.M.F.) of each cell as compared with a Latimer Clark standard cell by methods which need not be here described was found to be 1·470 volt, the variations on the different cells being inappreciable. This is fully equal to the E.M.F. that can be expected from this type of cell. The resistances of the cells were next ascertained under very severe conditions, viz., when generating heavy currents, varying from 2·25 to as much as 3·75 amperes. Notwithstanding the severity of the test the resistances were found to have the following very low values for the above size of cell:—No. 1 cell = ·222 ohm; No. 2 cell = ·166 ohm; No. 3 cell = ·121 ohm. Each resistance given is the mean of four measurements taken with currents varying within the above named limits.

The cells were then discharged in series through a constant external resistance for 45 hours continuously, the currents given varying from 113 milliamperes at the start to 36 milliamperes at the end of the test. These currents are much larger than the cells would ordinarily be called upon to give in any of the cases cited above, and the fact that they were maintained for such a long period without the cells being allowed to recuperate by intervals of rest augurs well for the practical use of the cells. Measurements of E.M.F. and resistance were made at intervals during the discharge. The details need not be given in this preliminary note, but it may be stated that at the end the E.M.Fs. were 76·2, 78·7 and 74·7 per cent. of their respective values at the beginning of the test, whilst the average resistance had only risen to a little over 0·4 ohm per cell.

The cells were next allowed to rest for five days, during which the E.M.Fs. returned to 99·0, 99·4, and 92·9 per cent. respectively of the before-named initial values. On discharging continuously for a further period of 24 hours through the same resistance as before the current fell from 108 milliamperes at the start to 80 milliamperes at the end of the time. Simultaneously the E.M.Fs. had fallen to 72·3, 74·0, and 68·8 per cent. respectively of the value at the commencement of the first test.

It may be remarked in passing that the variations in the fluctuations noted in the values of the E.M.Fs. show how very necessary it is in tests of this nature to discharge more than one cell under precisely similar conditions if reliable deductions are to be made of the general behaviour of the cells. Experiments, such as are sometimes made, on single cells may give very misleading results, owing to the particular cell experimented upon being either above or below the average, for it is impossible for any manufacturer to ensure absolute uniformity.

The above tests, which are merely preliminary, show that Dr. Lessing's cells compare very favourably indeed with other forms of dry cells as shown by published tests. Further tests are now being made under varying conditions on all the principal points which are of importance in connection with the use of primary batteries as current generators for small currents.

October 31st, 1895.

Further Report on Dr. Lessing's Dry Cells.

The following report is a continuation of a preliminary one dated October 31st, 1895, to which reference should be made for various descriptive details which will be found therein. The further tests, which will be dealt with presently, were designed chiefly to try the behaviour of the cells as current generators under different and varied conditions, and were all completed before Christmas, but private circumstances have prevented the writer from making his report until now.

It will be unnecessary to repeat generally what has been already said in the preliminary report, but, perhaps, attention may again be drawn to the importance of not making deductions from the behaviour of a single cell. All the subsequent experiments emphasise strongly the remarks previously made on this point, and in these experiments three cells were always discharged simultaneously under precisely similar conditions, and measurements were taken on each cell separately. The only doubt regarding the advisability of this course is as to whether more than three cells ought not to be used to get fair measurements of the average behaviour of the type of cell under test.

The E.M.Fs. were obtained by comparison with a standard Latimer Clark's cell by means of a condenser and sensitive ballistic galvanometer. Both charge and discharge readings were taken, and the usual well known precautions were adopted, the actual E.M.F. at the moment of breaking circuit being obtained by taking timed readings and plotting the results on curved paper.

The resistances were obtained by measuring the P.D. just before breaking the circuit and calculating in the usual way. Some remarks will be made on this subject later on.

For convenience, the tests may be referred to in two groups, namely, those in which the current was kept on continuously and those in which the currents taken were intermittent. The former will be described first.

In these tests, unless otherwise mentioned, the current was kept on continuously day and night, except that the circuit was broken occasionally for about a minute at a time to enable readings of E.M.F. to be obtained. It will perhaps be sufficient to mention three sets of tests.

In the first set three cells were discharged through a constant external resistance which was such that the current at starting was nearly 500 milliamperes or 0·5 ampere (more exactly, 435 milliamperes), a very large current to take from cells of this size. Notwithstanding this the cells maintained the current fairly well for rather more than six hours, during which time the fall of the current was less than 7 per cent. Shortly afterwards the cells fell off very rapidly, but their resistance at the end of the six hours was less than 0·2 ohm per cell.

In the next set three fresh cells were discharged through a larger constant external resistance such that the value of the current, after the cells had been at work a few minutes, was 42·5 milliamperes, a value approximating to the currents usually required from cells of this kind. At 27·2 hours from the commencement of the test the current had fallen to 39·4 milliamperes (92·7 per cent. of the above starting value); at 48·7 hours it was still 39·4 milliamperes; at 71·1 hours it had fallen to 37·3 (87·7 per cent.); and at 95·5 hours to 27·6 milliamperes. This last low value was due to the fact that one of the cells had become exhausted. This cell was therefore now cut out of circuit and the external resistance reduced to two-thirds of its value for the three cells. The current from the two cells then rose to 37·6 milliamperes (88·5 per cent. of the first value) and only fell to 26 milliamperes at 170 hours from the start. The two cells were now practically equal in E.M.F. and resistance, and though the discharge was continued for nearly 22 hours longer it is unnecessary to quote further measurements, as for all practical purposes the cells were exhausted.

The E.M.Fs. of the cells were 1·455, 1·470, and 1·466 volts before closing the circuit, and these fell off in much the same percentage manner as the current, though there were variations between the cells. It is not necessary to encumber the report with the detailed figures, but as an example it may be mentioned that at 71·1 hours the E.M.Fs. were 1·280, 1·297, and 1·308 volts respectively, or 88·0, 88·3, and 89·2 per cent. respectively of their original values. The current had fallen off rather more because the resistance of the cell, which was eventually cut out 24 hours later, had already begun to rise. When this cell was cut out its E.M.F. had fallen to 33·4 per cent. of its original value, but the other two cells had only fallen in E.M.F. to 62·0 and 62·5 per cent. of their initial values 74·5 hours later, or 170 hours from the start.

The behaviour of the cells with regard to resistance during these tests with small currents was not easy to examine. To measure the resistances very accurately would have necessitated the taking of much larger currents from the cells for short periods. To this course there are two objections: first, that it destroys the value of the tests for the particular currents under investigation, and, secondly, as was ascertained by actual experiment, the passage of these large currents affected, quite irregularly, the very resistance to be measured, which was sometimes diminished and sometimes increased. The resistance measurements for small currents are therefore only approximate.

In the set of tests now being described the resistance was less than 0·2 ohm for each cell at starting and remained at that value for over 24 hours. It then began to rise irregularly and in different ways in each cell till at the end of 48 hours it was about 0·5 ohm per cell. At the end of 72 hours it had fallen in two cells, but had risen to over 1 ohm in the third, which was the cell cut out 24 hours later. In a general way it may be said that the resistance fluctuated about the value of 0·5 ohm per cell until the cells were exhausted, and that the rise of resistance was a sign of approaching exhaustion more marked at first than the fall of E.M.F.

The next set of tests need not, perhaps, be referred to in such detail. In these a still larger external resistance was employed, such that the value of current after the first few minutes was 28·4 milli-

amperes, a current quite large enough for many purposes. After 48 hours the current was still 27·6 milliamperes, and at 70 hours was 26·7. At this time the circuit was accidentally broken for 1½ hours so that the cells had a short period of rest. The discharge was then resumed and the current fell off gradually till at 163·5 hours it stood at 21·8. This low value, as in the preceding experiments, was chiefly due to the exhaustion of one cell only. On cutting this cell out and reducing the external resistance proportionately the current rose to 25·6 and fluctuated between 26·0 and 25·4 milliamperes until the discharge had continued for 242·7 hours. At 266 hours the current was still 25 milliamperes, but 22 hours later it had fallen considerably and the cells were both exhausted.

The E.M.F. and resistance, allowance being made for the more extended periods of discharge, followed the same general course as in the experiments last described.

To sum up briefly, the tests show that with cells in good condition, currents of from 25 to 28 milliamperes may be taken continuously and without breaking circuit for 260 hours or longer, a result which may certainly be regarded as very satisfactory.

But one of the chief uses of this type of battery is not for the supply of continuous currents but for generating intermittent currents, and it was therefore considered desirable to examine the behaviour of the cells when supplying such currents, but still under conditions more rigorous than would probably be exacted in actual practice. A piece of simple apparatus driven by clockwork, but which it is unnecessary to describe in detail, was therefore constructed by which the circuit of a battery could be kept closed for four minutes and then opened for the six following minutes, to be again closed for four minutes, and opened for six, and so on for as long as was considered desirable. In this way the whole time of a test was broken up into intervals of ten minutes, and in each interval the current flowed without interruption for four minutes, and during the remaining six minutes the battery was allowed to rest and recuperate.

Two such series of tests will be here referred to. In both cases, for reasons already given, three cells were joined up in series, and the tests made on the three cells of each group simultaneously. In the first series the cells were allowed to discharge through a constant external resistance, such that the current at the end of the second four minutes was 258 milliamperes—a heavy current to take from such a battery for any extended period. The tests were continued for 96 hours. Before any current had been taken from the cells their E.M.Fs. were 1·505, 1·490, and 1·476 volts respectively, and the resistances after the above current had flowed for a few minutes were 0·54, 0·49, and 0·10 ohm respectively. It would thus seem that the two first cells for some reason had both a higher E.M.F. and higher resistance than most of the cells experimented upon, and perhaps on that account may be regarded as somewhat abnormal. At the end of 49 hours the E.M.Fs. had fallen to 79·8, 78·8, and 83·0 per cent. of their initial values, whilst the resistances had increased some 50 per cent.; at the end of the 96 hours the E.M.Fs. were 1·067, 0·935, and 0·766, or 71·0, 62·7, and 52 per cent. of their initial values. It is evident that at this time the battery was practically exhausted for this method of working. Nevertheless, the discharge was continued 50 hours longer, and then the battery allowed a complete rest of 23 hours. At the end of this period the E.M.Fs. had returned to 67, 70, and 62 per cent. of their initial values, but the resistances of the two first cells (the apparently abnormal ones) had permanently risen to the high value of over 2 ohms, whilst that of the third was now only 0·3 ohm. These tests show that a rest of six minutes is not sufficient to allow the cells to recuperate after supplying such a very heavy current for four minutes continuously. The next tests to be quoted show that with a smaller current of a magnitude more likely to be demanded in actual practice the relative times allowed for rest and work were more nearly suited to the capabilities of the cells.

In these tests, using the same clockwork apparatus as before for making and breaking the circuit, three new cells were taken and caused to discharge through a much larger constant external resistance. The resistance, which was not changed throughout the experiments, was such that the commencing current was 27·6 milliamperes. At the end of 167½ hours, throughout which currents of four minutes' duration were followed by rest intervals of six minutes, the current had only fallen to 26·4 milliamperes. The cells were next allowed to rest for some days and were then again discharged through the same resistance. The current started at 27·2 milliamperes, and, at the end of 213·4 hours further work, had only fallen to 25·0 milliamperes. Thus, after 380 hours of intermittent working, the current from the three cells through a constant resistance had only fallen 9·6 per cent. of its initial value. How much longer the battery would have maintained approximately the same current was not ascertained, as the experiments were interrupted by the intervention of the Christmas holidays.

Comparing, however, with the corresponding continuous current tests, we find that about the same percentage fall of current occurred after 308 hours' intermittent working as after 70 hours' continuous working. In 308 hours the current is actually on for 123 hours. Now, in the "continuous" tests the cells continued to give a good current for about 280 hours or 4 × 70. If we assume the proportion to hold, it would have taken 1,200 consecutive hours to exhaust the cells by the intermittent working. The calculation, though on a probable basis, must only be taken as approximate. Returning to the "intermittent" tests, it was found that the percentage fall of E.M.F. was fractionally (but very slightly) greater than the fall of current, because of the falling off in resistance referred to below.

The remarks previously made on measurement of resistance for small currents apply to these tests and should be borne in mind. At starting, the resistance of the first cell was less than 0·25 ohm, of the second was 0·3 ohm, whilst the resistance of the third was as high as 2·6 ohms. The resistances of the first two cells varied between less than 0·25 ohm and 0·5 ohm throughout the tests, whilst that of the last gradually diminished till it fell to about 0·3 ohm at the middle of the tests and afterwards showed much the same fluctuations as the other cells. The passage of successive currents through this cell therefore had the effect in time of breaking down its high resistance, and the tests show that each cell had a working resistance of 0·6 ohm to 0·25 ohm or less for currents of about 27 milliamperes, a result which may be regarded as very satisfactory.

In the preceding tests with heavier currents, where it was easier to make the resistance measurements, the fluctuations were wider and extended from 0·1 ohm to 0·79 ohm until the cells began to get exhausted, when the resistance in two cases rose rapidly, and in the third fell to below the mean value.

The above tests show conclusively that these cells are admirably adapted for generating intermittent currents of the magnitude usually required for many purposes, such as telegraphy, telephony, ringing electric bells, and for medical and other uses. The cells, for their size, have, as a rule, a very low internal resistance and consequently a high efficiency, since only a small proportion of the electric energy is lost in working against the internal resistance. They also have good recuperative power, and if the outside be kept dry the terminals are very well insulated.

The so-called test of trying how long a cell would ring an electric bell was not considered necessary, for, at the best, it is unscientific, and can only yield ambiguous results. This is at once evident when we consider that the current required to ring a given electric bell depends largely on the construction of the bell: moreover, much also depends on whether the current is kept at the minimum required to ring the bell or is allowed haphazard to be of any greater magnitude.

One other important property of Dr. Lessing's cells may be referred to in conclusion. Throughout the tests, even when the heaviest continuous currents were being taken, in no instance did a cell show any sign of bursting or of mechanical leakage. In this respect they compare favourably with some similar cells on the market which the writer has seen burst open by the expansion of the materials caused by the heat generated by heavy currents.

The cordial thanks of the writer are due to three of his students, Messrs. J. H. Hughes, C. A. Henderson, and M. Thomson, at the Heriot-Watt College, for the care taken in making the experiments, and to the two first-named for constructing the special apparatus required for the intermittent tests.

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February 1st, 1896.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

5,253. "Improvements in or connected with the electro-deposition of metals." S. O. Cowper-Coles. Dated March 9th.

5,263. "An improved process for the electroplating or metallisation of wood." H. A. V. Wirth. Dated March 9th.

5,274. "Improved apparatus for the electro-deposition of metals." A. S. Smith, T. A. Smith, R. J. Smith, S. Smith and T. Deakin. Dated March 9th.

5,295. "Improvements in arc lamps." J. A. Seaverns. Dated March 9th. (*Complete.*)

5,298. "Improvements in electric flash-light apparatus." A. J. Boult. (W. Bruns, United States.) Dated March 9th. (*Complete.*)

5,315. "Improvements in the method of and means for electrically dispatching parcels from one station to another." E. H. Seddon. Dated March 10th.

5,320. "An improved method of attaching the terminal wires to the zinc rods or cylinders of electric batteries." I. H. Parsons. Dated March 10th.

5,345. "Improvements in gramme ring armatures." R. Holiday and J. Freeman. Dated March 10th.

5,389. "An improved system of call suitable for use with autographic telegraph apparatus." H. P. Jackson. (H. Etheridge, United States.) Dated March 10th.

5,408. "Improvements in telegraphic relays." W. S. Smith and W. P. Granville. Dated March 10th.

5,412. "Improvements in selecting and operating telephones." T. McKenna. (H. L. Webb, United States.) Dated March 10th. (*Complete.*)

5,467. "Improvements in appliances connected with electric tramcars and tramways." E. H. Hackett. Dated March 11th.

5,479. "Improvements in alternating current electric motors for operating commuting devices for converting alternating into continuous currents and other purposes." A. S. Frazer. Dated March 11th.

5,480. "An improved method of and means for locating leakages on systems of electric conductors." W. V. Hunt. Dated March 11th.

5,491. "Means for varying the speed of asynchronous alternate current motors." Siemens Bros. & Co., Ltd. (Siemens and Halske, Germany.) Dated March 11th.

5,497. "An electrically controlled automatic stopcock." S. R. Bottone. Dated March 11th.

5,506. "Improvements in electric accumulators." P. F. Ribbe. Dated March 11th. (*Complete.*)

5,511. "Improvements in arc lamps." W. J. Davy. Dated March 11th.

5,537. "Automatic telegraph apparatus." G. Hyvert. Dated March 12th.

5,563. "Improvements in magnetic compasses for night marching and course indicating." J. H. Steward. Dated March 12th.

5,584. "Improvements relating to the use and treatment of carbon in electro-chemical or electrolytical processes, and to apparatus therefor. A. Coehn. Dated March 12th.

5,616. "Improved electrolytic processes and apparatus." A. E. Peyrusson. Dated March 12th.

5,673. "Improvements in apparatus for refining metals by electrolysis." A. S. Elmore. (J. O. S. Elmore, India). Dated March 13th.

5,703. "Improvements in arc lamps." A. J. Boult. (W. B. Jolles and E. H. A. H. R. von Nollendorf, Austria). Dated March 13th. (*Complete.*)

5,752. "Electric apparatus for use either as an electromotor or or as an electricity meter." J. Perry. Dated March 14th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1895.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps.*)]

2,064. "Improvements in automatic switches and in their use for distribution of electricity." J. Hopkinson. Dated January 29th, 1895. Refers to specification 22,876 A.D., 1893. An electro-magnet or magnets are used, the wire of which is connected to the terminals the difference of potential between which is to determine the action of the switch. In order to secure a step-by-step working, the magnet is short-circuited, or its circuit is broken by means of an auxiliary switch operated by the main switch controlled by the electro-magnet. Consequently, when the electro-magnet has operated the main switch it is immediately restored to its former condition so as to again operate the main switch to a further extent if necessity arise. 1 claim.

2,218. "Improvements in or relating to 'watt-hour' counters for alternating currents of electricity." G. Hummel. Dated January 31st, 1895. Relates to the construction of a special form of electric motor for use in electricity meters. In this motor there is a field magnet of iron having a compound winding and an armature consisting of a hollow copper cup surrounding a mass of iron. The magnetic circuit of the magnet is arranged to have a considerable air-gap. Provision is made for causing the motor to start in the right direction when the shunt current alone is passing through it. 5 claims.

2,228. "An improved combined starting, reversing and controlling electric switch for operating electric motors." W. A. Clatworthy. Dated January 31st, 1895. Relates to a switch in which, by the movement of a single handle to successive position, the batteries may be connected to the motor terminals in different ways, so that the motor may be caused to go fast in either direction or slow in either direction. 4 claims.

2,805. "An invention designed to regulate or assimilate the movements of electrically connected mechanical instruments or machines, more particularly wheels or other bodies revolving on axes, and to diminish variations in the movements or speed of the same by means of electrical impulses." R. J. Crowley, H. W. C. Cox and C. F. Leighton. Dated February 8th, 1895. Relates to synchronisers. The two mechanisms are each provided with a special rotating portion which at one point in its revolution bridges one of two gaps in an electric circuit. If one gap be bridged by one mechanism before the other that mechanism is stopped until the other gap is bridged, when the retarding means is removed, and both mechanisms are thereby brought into synchronism." 1 claim.

3,055. "Improvements in or connected with electric steering apparatus." F. King. Dated February 12th, 1895. Relates to carriages, boats, or other vehicles which are steered electro-mechanically. By means of the new device when the steering mechanism has been moved to give the vehicle the required change of direction, and it is desired that the vehicle shall continue its course in a straight line from its new position, the steering mechanism is caused to do this by merely turning the steering handle back to zero. 2 claims.

6,048. "Improvements in the manufacture of flexible sheets for electrical insulation." C. W. Jefferson. Dated March 23rd, 1895. The insulating sheets are made of alternate layers of mica scales and a fibrous material, such as paper, cloth, or fabric, with a fine sheet of gutta-percha tissue interposed between each two layers of other material. The number and sequence of the layers may vary. The whole product is then heated until the gutta-percha tissue becomes adhesive, and is then pressed, and when the sheet becomes cool the layers adhere to one another and form a flexible sheet that can be cut and bent into every form. 7 claims.

7,319. "Improvements in and relating to electrical hot plates." Thomas Fletcher, W. Russell and Fletcher Russell & Co. Dated April 10th, 1895. Relates to the construction of an electrical hot plate used for working and heating purposes, and provided with suitable holes and perforations of any desired shape. The conductors are arranged about, around, or between the holes upon the solid parts of the plate. The solid parts are slightly convex or conical, or are otherwise formed to shape downwards towards the perforations, so that any liquid or the like falling upon a solid part, immediately runs down towards and is discharged through one of the perforations. Owing to the convex or other form of the solid parts of the plate, these parts have a greater effective heat radiating surface than they would have if they were flat. 2 claims.

9,273. "Improvements in tubular electro-magnets." J. Taylor. Dated May 10th, 1895. In the construction of tubular electro-magnets for telephones, it is desirable to reduce the magnetic resistance between the core and the tube of the electro-magnet. To get the lowest magnetic resistance the yoke between the tube and core is sometimes made solid with the tube by taking a solid bar of iron and boring this out to form a tube and yoke. This improvement consists in producing a combined tube and yoke without joint, by a process of stamping out of sheet Swedish iron. 3 claims.

21,381. "Improved manufacture of carbon rods for arc lights." J. Roubal. Dated November 11th, 1895. Relates to a process of manufacture of carbons which do not oxidise at their surfaces. The carbons are impregnated with a composition of equal quantities of carbon, such as soot or finely pulverised graphite or pure coal, and a silicate such as waterglass and then dried rapidly. The silicate combines intimately with the surface of the carbon and incrusts it. Carbons united to a smaller intensity of current are advantageously impregnated with boracic or phosphoric acid or their salts. 2 claims.

22,337. "Improvements in incandescent electrical lamps." The Edison and Swan United Electric Light Co., Ltd., and A. W. Hill. Dated November 22nd. Relates to the construction of the bulb and holder of the lamp in such a manner as to shorten the leading in wires and lessen the risk of their short circuiting, and to afford a ready means of putting the filament, or one of the filaments, in or out of circuit. The top of the bulb is formed to contain switch contacts to which the leading in wires are joined, the holder fitting on the top has corresponding contacts to which the leads are connected. By turning the lamp round, the circuits can be made and broken as desired. 1 claim.

22,600. "Improvements in and relating to a system of telegraphic communication." I. Kitsee. Dated November 26th. Alternating induction currents are used together with a "Morse" key for sending currents of longer or shorter duration, a vacuum tube being provided as the receiver. This system may be used with or without a continuous metallic circuit. 10 claims.

22,696. "Improvements in alternating current arc lamps." W. P. Thompson. (W. Mathieson, Germany). Dated November 27th. The inductive repulsion of rings, coils, or discs placed in front of the poles of an alternating current magnet, is utilised for striking the arc and regulating the same. 2 claims.

24,098. "Improvements in continuous current generator dynamos or motor dynamos." A. de Puydt and M. Poncin. Dated December 16th, 1895. Consists in dividing the pole-pieces of the field-magnet into several parts arranged either inside or outside the armature, in combination or not with supplementary brushes connecting one section of the armature with a short circuit, for the purpose of diminishing the reaction or electrical resistance of the armature as described. 4 claims.

24,354. "Improvements in electrical switches." C. M. Dorman, R. D. Smith, and H. G. Baggs. Dated December 19th, 1895. The moving contact pieces or brushes are attached to a bar or rod which is carried at two or more points in its length on rocking levers or links, which are pivoted at one end to fixed points on the base of the switch, and at the other end are pivoted to the base or rod, the arrangement being such that the bar or rod can be rocked lengthwise backwards and forwards on the links, carrying with it the moving contact pieces into and out of contact with the fixed contact pieces.

24,514. "Improvements in means or devices for holding electric incandescent or glow lamps." R. Hacking and J. Bennett. Dated December 21st, 1895. The ends of the lamp terminals are arranged on opposite sides of the cap of the lamp which is adapted to fit into a holder lines with cork, asbestos, cloth, or other material of a gripping nature, which holds it in position. Two contact strips in the holder connect with the lamp terminals when the lamp is placed in the holder. 4 claims.

24,516. "Improvements in secondary voltaic batteries." L. Epstein. Dated December 21st, 1895. The positive plates are contained in casings of porous material open at the bottom. The negative plates consist of copper gauze coated with zinc amalgam, and have their bottom edges resting in trays or troughs which catch any mercury or amalgam dropping off said plates. 2 claims.

24,710. "Improvements in lightning arresters for high potential electric circuits." J. Devonshire. (W. B. Potter, U.S.A.) Dated December 24th, 1895. Lightning arresters for use with either high or low potential circuits, and for alternating or direct currents are made with a number of spark gaps in series, each gap enclosed in a separate chamber of insulating material. A means of extinguishing the arc is provided which preferably consists of a magnetic coil having no iron in it and arranged to serve all the gaps. 5 claims.

1896.

964. "Improvements in telephonic apparatus." C. J. Schwarze. Dated January 14th, 1896. Relates to telephonic apparatus in which a magnet telephone transmitter is arranged to be used as a signalling apparatus. For this purpose the electro-magnet is arranged to be rotated between the poles of a permanent magnet so that a signalling current may be sent. In a modification the bell is also combined with the transmitter. 8 claims.